MACHINERY

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TOOLS FOR PERFORATING LAMP BURNER PARTS

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MANY kinds of dies have been described by the trade papers in the past, but very little has been said of the dies used for perforating the sides of cylindrical work. The punches and dies used for this work are similar to blanking punches and dies, except for the modifications occasioned by the fact that the metal fed over the face of the blanking die is flat, while that fed over the face of the perforating die is circular in form. Circular perforating tools are used in connection with this class of work because the nature of the work is such that it cannot, on account of both

stroke of the press, cut out two of the irregular shaped perforations B in the shell. On the upward stroke of the press, a pawl A, Fig. 2, by the aid of a ratchet B, ratchet shaft C and the bevel gears, revolves the driving arbor, which rotates the shell a part of a turn. As the slot in the bottom of the shell is engaged with the tongue of the driving arbor, the shell is indexed with the arbor before the punch descends again. These operations are continued until the press, in this case, has made fourteen continuous strokes, when it is automatically stopped and the perforated shell removed. The
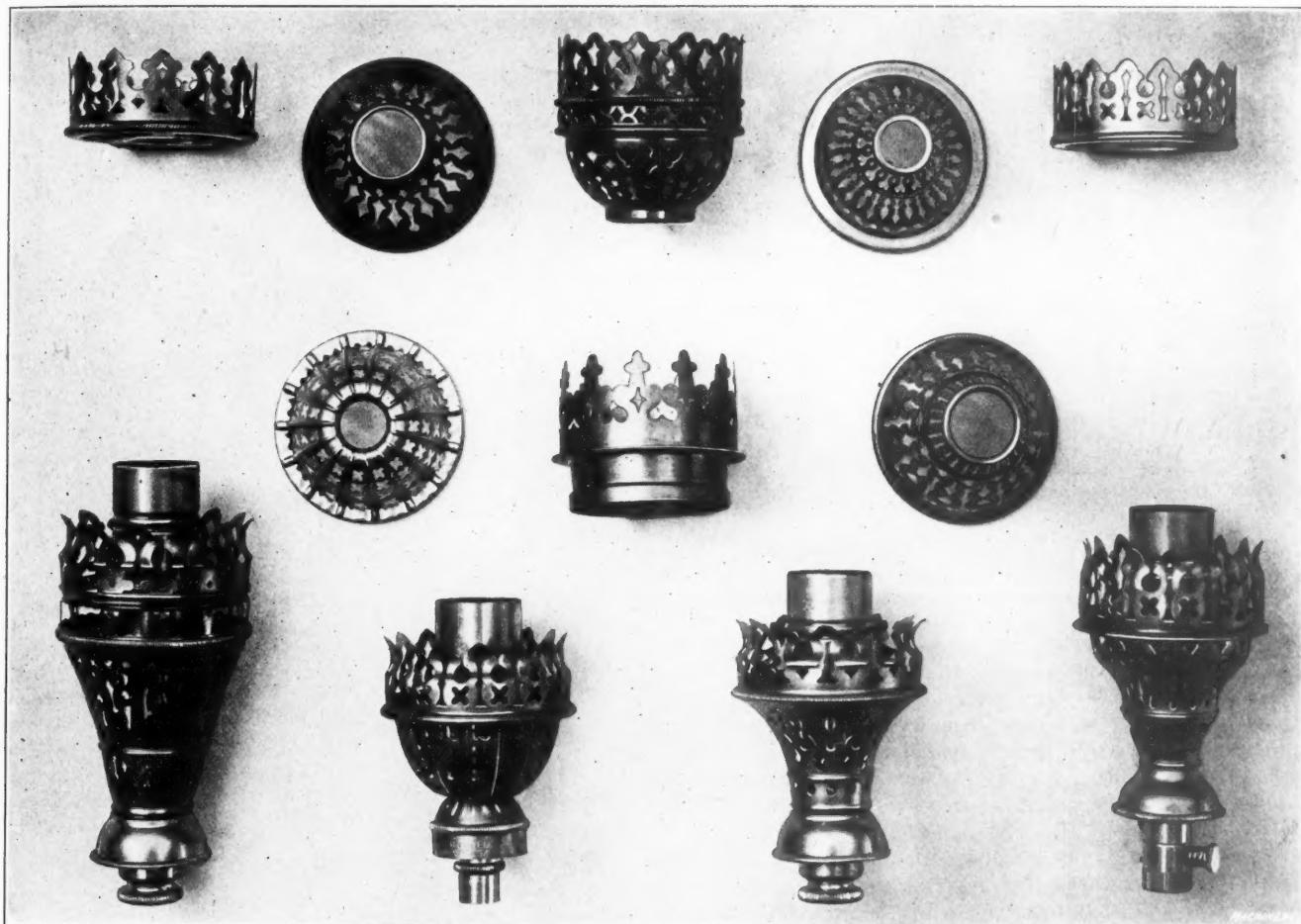

Fig. 1. Examples of Perforated Cylindrical Work, made by the Scovill Mfg. Co., Waterbury, Conn.

commercial and mechanical considerations, be carried out in any other way.

In describing the perforating of cylindrical work, the writer does not claim that the tools and methods in every case are the very best possible, but those in successful commercial operation at the present time are illustrated and described. The writer extends thanks to the E. W. Bliss Co., of Brooklyn, N. Y., for cooperation in the preparation of this article, and also to the Scovill Mfg. Co. of Waterbury, Conn., for the loan of the samples of perforated work shown.

Operation of the Perforating Tools

In Fig. 2 is shown a set of perforating tools together with a perforating attachment set up in a Bliss press ready for perforating a shell similar to the one shown in Fig. 4. The shell is first slipped over the die-holder (Fig. 5) in such a manner as to allow the elongated slot A in the bottom of the shell to engage with the projecting tongue of the driving arbor. The press is then tripped and the punches, at the first

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stopping of the press is effected by cam D, which automatically releases the driving clutch when the required number of strokes has been made. The construction of the tools and the manner in which they are made will be treated later.

In Fig. 6 is shown another set of perforating tools for perforating the gallery fence of a lamp burner shown in Fig. 7. The gallery fence of a lamp or gas burner holds the lamp chimney or globe in place by the spring pressure exerted by the perforated part. The metal must be hard in order to impart the required spring pressure and is, therefore, on the better grade of burners, burnished before perforating, which not only hardens and toughens the metal, but also produces a brilliant finish. On the cheaper grade of burners, the shells from which the gallery fences are made are passed through an extra re-drawing operation, the shells not being annealed, but left hard. The difference in the diameter of the shell before and after re-drawing is about 1/32 inch, while the difference in the thickness of the metal is about 0.0005 inch. This treatment of the metal not only imparts the required springi-

ness, but also makes the perforating operations easier, as hard metal is more readily perforated than soft.

The tools used for perforating the gallery fence shown in Fig. 7 are somewhat different in construction from those shown in Fig. 2. The ratchet C, Fig. 6, is keyed to the driving arbor, and when the tools are set up in the press they are set with the face of the die-holder turned towards the right, instead of facing the operator. The perforating operation, however, is similar to the one already described. The effect of the successive strokes of the press is indicated in Fig. 7. At the first stroke of the press, the four shaded areas at F
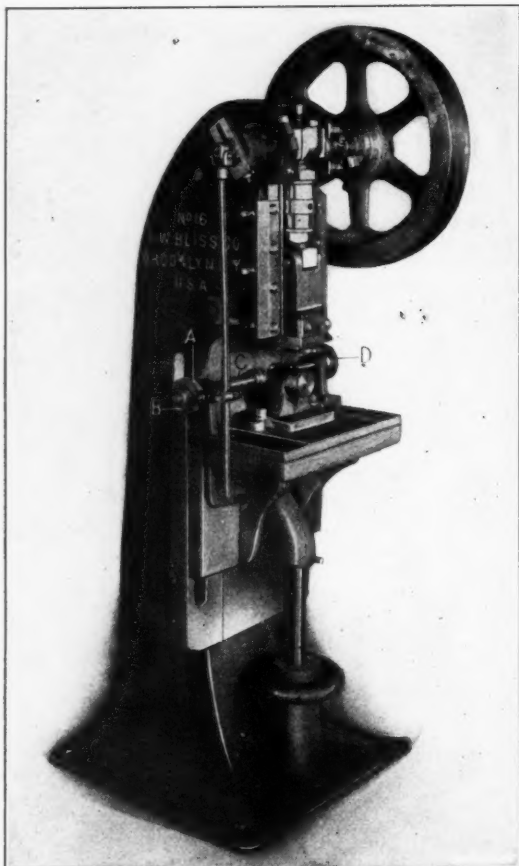

Fig. 2. Bliss Press with Attachment for Perforating Shell shown in Fig. 4

are punched out. At G can be seen the appearance of the shell after the second stroke. In order that no burr or fin may be left on the top points of the scallops, the die is made so that the punch will cut a trifle past the center of the point as shown at H. The shell is rotated towards the left by the driving arbor, and a simple holding device, not shown in the illustration, is used for holding the shell in place on the arbor.

At attachment for holding work in place while it is being perforated is shown in Fig. 3. This attachment is used in connection with the tools for perforating the sides of large narrow rings. The tool equipment consists of a perforating punch A, and a large die-holder B for holding the dovetailed perforating die C. The die-holder is held in die-bed D. The perforating attachment, which rotates the shell, is placed directly back of the die-bed and is operated by the adjustable connection E, fastened to the gate of the press. After the ring is slipped over the die-holder, handle F is given part of a turn to the right which, by means of the spiral grooved arbor G, causes the circular disk H to come in contact with the ring, thus holding it in place. This circular disk rotates with the ring and is attached to arbor G by a pin in the hub of the disk which engages with a circular groove in the arbor.

Construction of Perforating Tools

In Fig. 8 the perforating die for the shell in Fig. 4 is shown held in a dovetail channel in the die-holder. The die-holder is preferably made of a cheap grade of tool steel, and is held in the die-bed as shown in Fig. 5. The dovetail method for holding the dies is probably the best, and is the one most commonly used. The sides of the dies are beveled at

an angle of from 5 to 10 degrees. For work such as shown in Fig. 4, the die is tapered lengthwise on one side with a taper of about 1 degree, and is driven into the die-holder from the back and left flush with the shoulder of the holder, so that when in position, the die-bed prevents it from shifting back. When it is possible to do so, a pin or a fillister head screw may be used to prevent the die from shifting endwise. The shape of the shell and the design to be perforated sometimes governs the taper of the sides of the dies. This, for example, is the case where shells such as shown in Figs. 10 and 12 are perforated, when a greater angle than 1 degree must be used on account of the irregular shape of the die-holder and dies.

The longitudinal cross-section of the die-bed, die-holder and driving arbor used for the shell in Fig. 4, is shown in Fig. 5. Section A shows how the arbor is milled at the neck A in order to allow the scrap punchings to drop through. A section of the tongue of the arbor which engages the slot in the end of the shell, by means of which it is rotated, is shown at B. This tongue is tapered as shown, to facilitate the putting on and taking off of the work. A scrap escape hole C is drilled in the die-holder at an angle as shown, so as to prevent the scrap punchings from coming in contact with the shell while it is rotated around the die. An escape hole drilled in this manner can only be used on short shells and when the scrap punchings are small, or, if they are large, when they are few in number. Hole D in the die-bed permits the scrap punchings to readily fall out of the way.
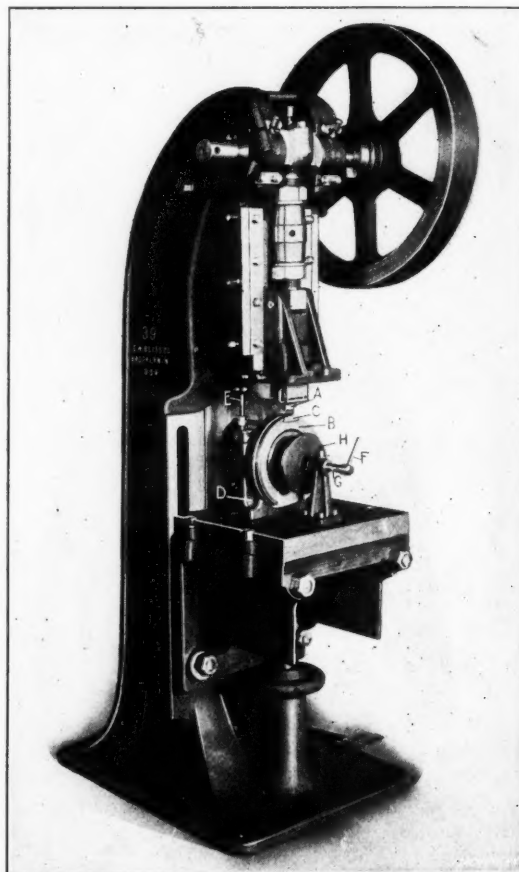

Fig. 3. Perforating Attachment with Special Device for Holding Shell in Place

The construction of the tools shown in Fig. 6 is somewhat different. Two small pins E, which are used in the face of the driving arbor, act as driving pins for rotating the shell. These enter into pierced holes in the bottom of the shell as shown at B, Fig. 7. The pawl which operates the indexing ratchet is fastened to part B in Fig. 6, which is made to fit the shoulder of the ratchet and works back and forth in order to provide for the required indexing. The back-and-forth motion is imparted to B by fastening a handle F to an adjustable connecting-rod which is, in turn, fastened to the crankshaft of the press. Part D is a brass friction which takes up the backlash of the driving arbor. This friction is fastened to the die-bed by a screw at G. The hole in the center of the friction fits the shoulder on one end of the

ratchet. The brake or friction effect is applied by screw *H*. Part *A* acts as a steadyrest for the driving arbor, and is fastened to the die-bed by screws *J* and *K*.

The cam fastened to the end of the driving arbor causes the press to stop automatically by coming in contact with a lever connected to the driving clutch. The driving arbor is relieved at *L* to prevent the congestion of the scrap punch-
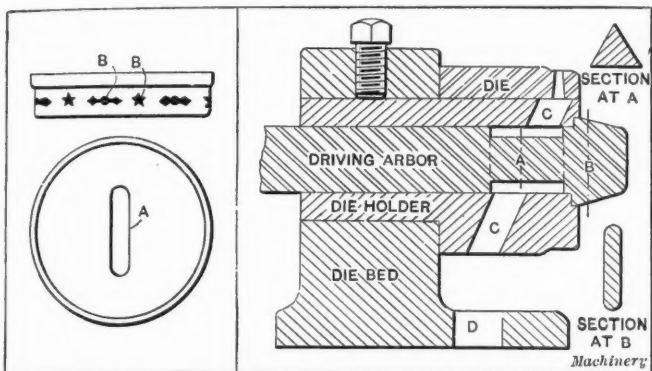

Fig. 4. Example of Shell to be perforated   Fig. 5. Section of Die Bed, Holder and Die for Perforating Shell in Fig. 4

ings. The hole for the driving arbor in the die-holder is also recessed at this place in order to give the scrap punchings, which, in this case, are rather large, ample room to pass the arbor. When the device is in operation, a shutter *M* closes up the bottom of the scrap escape hole in the die-holder. When the shell is slipped over the latter, the shutter is forced up and thus acts as a trap, preventing the punch-

Eight holes at a time are cut, or four holes in each row. The reason that four holes in each row are cut at each stroke, instead of five, six or eight, is, in the first place, that the number of holes cut at each stroke of the press must be such that the total number of holes in each row is a multiple of it. In the second place, it is not possible to get good results if the end punches are too far away from the center of the work, as these punches would strike a glancing blow. These holes would be somewhat elongated and "burry" instead of being clean, round and free from burrs. In this case, four holes in each row is as much as is practicable. Of course, if the holes are small in diameter and close together, a greater number can be cut at one time than when they are larger and further apart. If the diameter of the shells is large, a greater number of holes can also be cut at one time than with shells of smaller diameter, other conditions being equal.

In Fig. 11 is shown another set of perforating tools set up in a Bliss press. These are used for perforating the sides of the tube shown at *A* with a series of rows of small holes. These tools are of a somewhat different type from those already described. No driving arbor is used, but the shells are rotated direct from the ratchet which is placed in front of the die-bed. There may be several reasons for using this construction: When the bottom of the shell is to be left intact, no driving arbor can be used; sometimes the required shape of the shell is such as to prevent the use of a driving arbor; when the scrap punchings are so large and so numerous as to prevent them from dropping through if a driving arbor is used, or when that part of the shell that is
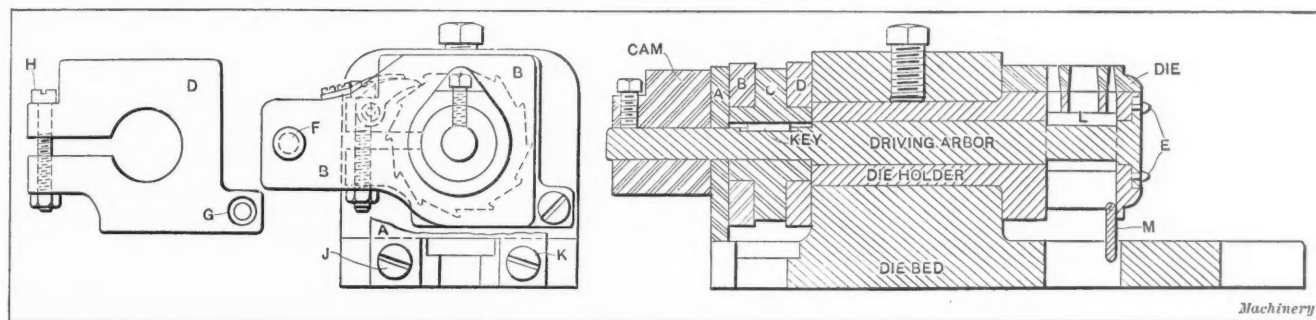

Fig. 6. Section of Die Bed, Holder and Arbor for Perforating Shell in Fig. 7

ings from dropping through into the inside of the shell. If the punchings were allowed to drop through and should cling to the perforated holes, they would cause the shell to jam and prevent it from rotating. When the perforated shell is removed from the die-holder, the shutter drops down of its own accord, thereby allowing the scrap punchings to drop out.

Perforating Shells of Tapered and Irregular Shapes

In perforating shells of tapered and irregular shapes the same general methods of procedure as already described are used, with the exception that the die-holder is held in the die-bed at an angle of 5 to 70 degrees or more with the bottom of the die-bed, the angle depending on the shape of the shell and the perforations to be made in it. In Fig. 9 is shown a die, die-holder and die-bed for work of this kind. The angle at which the die-holder is set should be such that if the outer ends of the two extreme holes in the perforating die are connected by a straight line, this line would be parallel with the bottom of the die-bed, as indicated in Fig. 10, where the points *A* and *B* are on the line which should be parallel with the base of the die-bed.

In Fig. 9 may also be seen the shell which is perforated by the die. The shell is rotated around the die by the tongue of the driving arbor engaging in an elongated hole in the bottom of the shell. The arbor is relieved at *A* in the usual manner to allow the scrap punchings to escape. No shutter is used, as the open end of the shell does not come near the scrap escape hole. The ratchet *B* which is operated by a pawl, not shown, is keyed to the driving arbor, while the friction used for controlling the backlash bears upon the shoulder of the ratchet as indicated. This shell has two rows of perforated holes, fifty-two holes in each row.

to be perforated is very small in diameter, it may also be impossible to use a driving arbor.

Referring again to Fig. 11, it will be seen that another set of perforating tools similar to the one set up in the press is shown to the left. This is used for perforating the shell shown at *B*. The ratchet and pawl are shown at *C* and *D*.
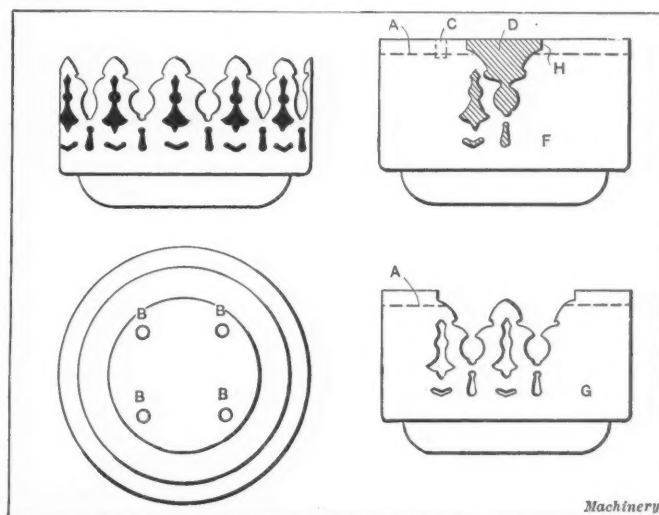

Fig. 7. Shell to be perforated, showing Successive Operations

The latter is fastened to the dovetail slide *E* in the die-bed *F*. This slide is operated by the gate of the press by connection *G*. The holding-on attachment consists of a slotted stud in the die-bed to which a swinging arm is pinned. A circular disk which revolves with the work is fastened to this arm, as is also the small handle directly in front of the

attachment. This handle is used by the operator to swing the arm up and out of the way preparatory to removing the perforated shell from the die-holder.

A method commonly used in connection with perforating tools for rotating the shell to be perforated is the dog-notch method. A dog C, Fig. 10, is fastened to the ratchet by screws or dowel pins. The end of this dog fits a notch D in the shell, called the "dog-notch." The shell is slipped over the die-holder in such a manner as to cause the dog-notch in the shell to engage with the dog on the ratchet. In this way the ratchet can index the shell directly around the die-holder.

There are also a number of other methods used for rotating shells to be perforated. Besides those already described, one may make use of an irregular shaped hole in the bottom of the shell in connection with the driving arbor. Sometimes an irregular shaped hole is required in the bottom of the shell, and in such a case the tongue of the driving arbor may be made to fit this hole, which affords a good driving means. Sometimes use is made of a coaster brake device fastened to the ratchet. The tools used in connection with this device are similar to those already described, having the ratchet in the front of the die-bed, as shown in Fig. 10, with the exception that instead of using a dog, a device working

Fig. 8. Die in Position in Die Holder

on the principle of a coaster brake, such as is used on an ordinary bicycle, is fastened to the ratchet. With this device, no notch in the shell is required, as the open end of the shell is simply slipped into this device and given a part of a turn, causing it to be tightly gripped. The press is then tripped and the shell rotated around the die in the usual manner.

In cases where a dog-notch is used and where there is a tendency on the part of the shell to slip in between the dog and the die-holder, which would prevent the shell from being
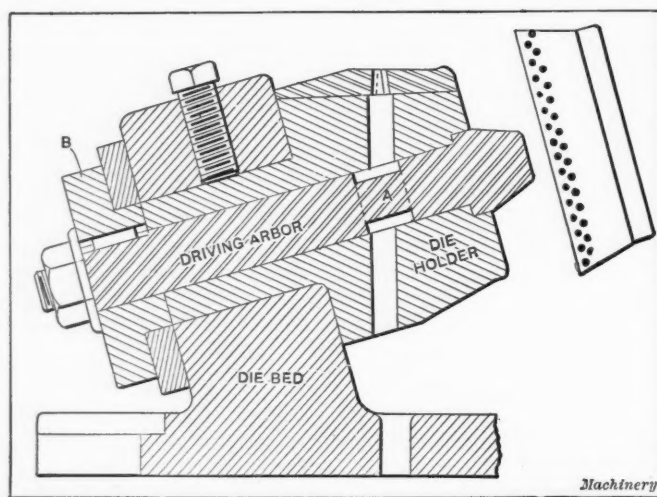
Fig. 9. Die, Die Bed and Holder for a Tapered Shell

properly rotated, the die-holder is turned down as shown in Fig. 10, and the dog is made to just clear the holder. This prevents the shell from slipping in under the dog.

The perforating die shown at H is held in the die-holder in the usual way, and is tapered lengthwise at a suitable angle as indicated. In order to afford a support for the die when in use, the bottom of the dovetail channel upon which the die rests is worked out so as to conform to some extent to the shape of the bottom of the die. This is done on dies

where the holes are close together, so as to support the narrow bridges that separate the irregular shaped holes in the die. The best way to do this work is to first work out an open space under the dovetail channel. This space is used for holding the scrap punchings that are prevented from dropping through by a shutter. In working out this space
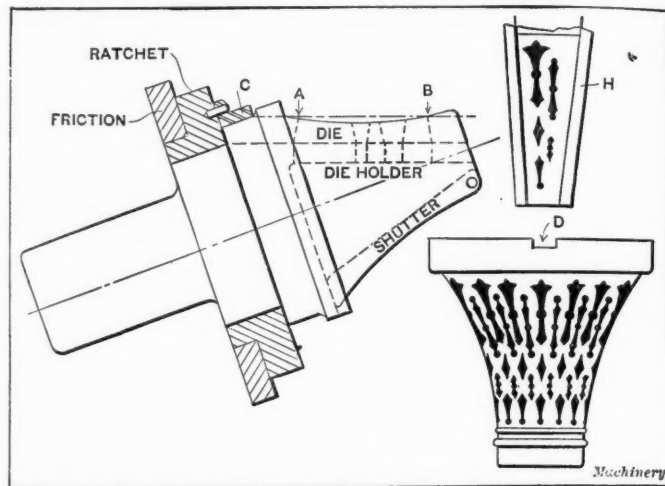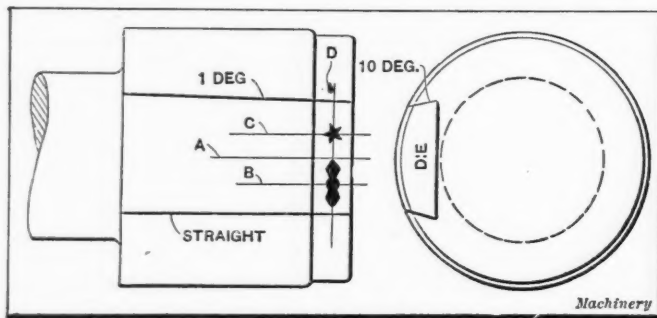

Fig. 10. Die and Holder for Perforating Shell shown to the Right

enough stock is left under the dovetail channel to support the die properly, as indicated in Figs. 10 and 12, after which the openings through which the scrap punchings from the die drop are worked out. The shutter which is shown closed in Figs. 10 and 12, swings open on the shutter pin as soon as the perforated shell is removed from the die-holder.

The construction of the tools in Fig. 12 is similar to that of those just described. At the right is a plan of the die, showing the manner in which the die is tapered lengthwise, which in this case is six degrees on each side. When
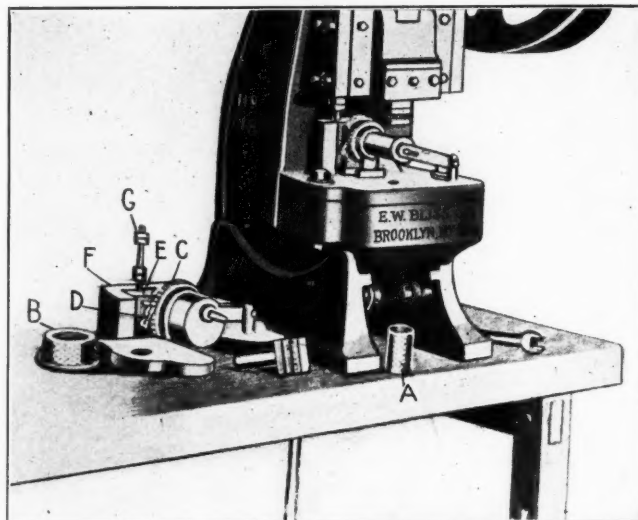

Fig. 11. Tools for Perforating Special Cylindrical Shells

the tools shown in Figs. 10 and 12 are in operation, two rows of holes are cut at every stroke of the press until the shell has completely rotated around the die and all the required rows of holes have been punched out. No device is used with these tools for holding the shells in place while they are rotating around the die, because the position of the die-holder in the die-bed makes it easy for the operator to keep the shell in place.

It sometimes happens that a perforated shell of the general type shown in Fig. 7 is required, with the exception that the bottom is left intact and therefore cannot be used in connection with a driving arbor for rotating the shell. In such a case, the shell is dog-notched and rotated in the manner already described, with the exception that the locating of the dog on the ratchet preparatory to perforating the shell forms an important part in the successful operation of the tools. The reason for this is that when cutting out the scallops of the shell, the dog-notch C, Fig. 7, which is used for rotating the shell must necessarily be cut away from the

shell, and must, therefore, be placed in such a position that it will come in the center of the large scrap punching which will be cut out at the last stroke of the press, completing the operation. If the shaded portion shown at D in Fig. 7 is the punching resulting from the first stroke of the press, and if the blank is rotating from right to left, then the dog-notch must be located at C, central between the two scallops completed by the last stroke of the press, after the whole shell has been perforated.

In order to prevent the punch A, Fig. 14, which cuts out the scrap punchings D, Fig. 7, from coming in contact with the dog, a short slot is milled in the center of the face of
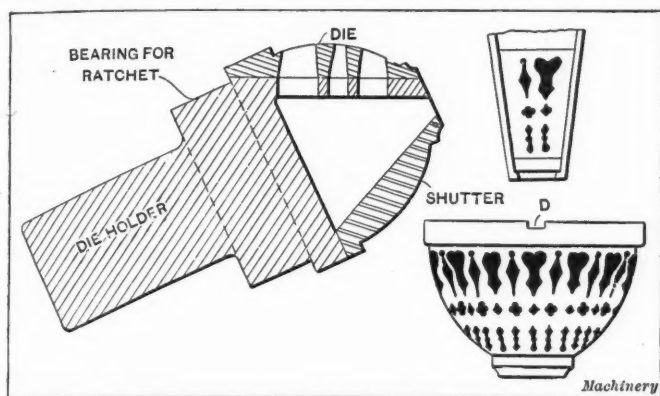

Fig. 12. Die and Holder for Perforating Shell shown

the punch at the back end near the ratchet, so that the punch will clear the dog when that part of the shell containing the dog-notch is cut out.

Lay-out of a Perforating Die

Preparatory to laying out the die shown in Fig. 8, the die-blank is carefully fitted to the dovetail channel in the die-holder, after which it is turned up in the lathe in place and highly polished. It is then removed from the die-holder and blued by heating, and again driven into the die-holder, after which it is ready to be laid out. The die-holder is then mounted in the milling machine, the index head in this case being set for twenty-eight divisions, as there are fourteen perforated holes of one design and fourteen of another. With a surface gage and by aid of the index head, the center lines B and C are scribed. Line A is merely drawn to show the center of the die, and the center of each one of the holes in the die should be an equal distance from this line. Center line D is next scribed the required distance from and parallel with the face of the die-holder.

In laying out the hole on the center line B a small circle of the exact diameter of the circular opening in the center is first scribed. The diamond-shaped ends are next laid out and scribed. The star-shaped hole on the center line C is laid out from a master punch which conforms to the required size and shape. In cases where the required number of shells to be perforated does not warrant the making of a master punch, the dies are laid out from the star-shaped punch that is used in connection with the die.

In working out the die, the central hole from which the star design is made is first drilled and taper-reamed from the back to the size of the teat on the master punch, which is equal to the diameter of the circle passing through the bottom of the grooves in the star. The teat of the master punch is then entered into the die and the punch set and clamped to the die so that a point of the star is on line C. The outline of the punch is then scribed on the face of the die, after which the die is worked out and fitted to the punch. In order to facilitate matters, the punch is used as a broach after the die is filed to shape. In working out the other hole in the die, on line B, a hole is first drilled and taper-reamed from the back for the circular opening in the center. Two holes are drilled and reamed in the center of the diamond-shaped ends. The surplus stock between the drilled holes is then removed and the hole filed to the desired shape.

There are two ways in which a die such as that shown in Fig. 13 may be laid out. One is to lay out the die on a milling machine in a manner similar to that already described. The other, which is most commonly used, is to lay out the die by scribing the design on its face from a master shell which is slipped over the die-holder and has the shape to be perforated upon it already worked out.

The master shell itself is laid out as follows: The shell is fastened to the die-holder by a few drops of soft solder to prevent it from moving. The die-holder is then mounted in the milling machine. The index head in this case is set for twenty-four divisions. In Fig. 13 is shown the laying-out of the die, but the same method applies to the shell. With a surface gage used in connection with the index head, the lines A, B, and C are scribed on the shell. Lines A and C represent the centers of two adjoining scallops, and line A is also the center for the two holes I and H, while line B is exactly in the center between two scallops and constitutes the center line for hole G. The lines E and D are next scribed on the shell, the former representing the height of the ears of the projecting scallops, while the latter shows the height at which the lower curved portions of the pointed scallops converge. After these construction lines are scribed on the shell, the design is readily laid out. The shape of the design is then worked out by drilling and the surplus stock is removed by means of a jewelry saw. The shell is then filed to the desired shape and when completed should be a duplicate of the portion cut out by the first stroke of the press, as shown at F in Fig. 7. In filing out a design, care should be taken to file out all the holes central with the center lines A, B and C, and also parallel with a plane passed at right angles to the center of the design, through the shell, in order that the holes may be at their exact required position on the inside of the shell.

It will be noted in Fig. 13 that the large hole F in the die is extended past the line D; this is done in order to make sure that the large scrap punching D, Fig. 7, will be
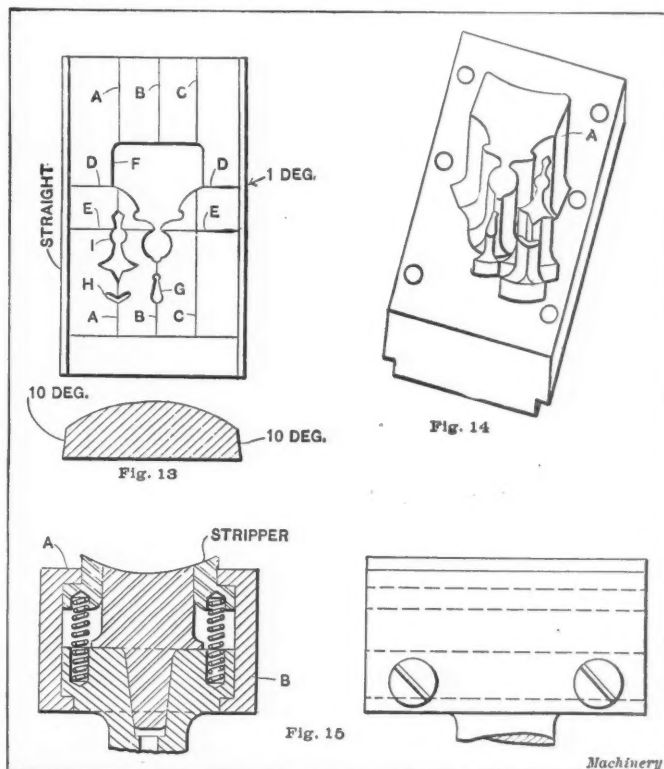

Fig. 13. Laying out a Perforating Die. Fig. 14. Perspective View of Perforating Punch. Fig. 15. Punch Holder and Stripper, showing Punch, Fig. 14, in Section

completely cut from the shell. This is especially necessary when the shells vary in length. The dotted line A, Fig. 7, is drawn so as to more clearly show the length of the twelve pointed scallops, and their relation to the top of the shell.

In drilling and working out the surplus stock in the die Fig. 13, the same general methods that are used for working out an irregularly shaped blanking die are used. First, remove as much of the surplus stock as possible by drilling. When drilling out the surplus stock in the hole F, the smaller of the two circular openings between the scallops is first drilled out and taper-reamed from the back to the finish size.

After this, the hole is plugged with a small taper pin that is filed to fit it, and the large hole is drilled and taper-bored in a lathe. The round corners at the opposite end of the hole are then drilled out. These corners are left circular in order to add to the strength of the die and to prevent cracking of the die in hardening. The remainder of the hole is drilled and worked out in the usual way. In working out the small holes G and H, the opposite ends are first drilled and taper-reamed to the finish size, after which other holes are drilled and reamed and the surplus stock is removed with a small broach or jewelry saw preparatory to filing out the die. Hole I is drilled out and the surplus stock removed in a similar manner.

Filing Out the Die Shape

A die used for perforating the sides of cylindrical work is rather awkward to hold, either in the vise or in die-clamps while being filed out, owing to the fact that the face of the die is circular in shape and the sides are dovetailed. For this reason, a die-holding fixture, shown in Fig. 16, is used to hold the die in the vise, die-clamp, or filing machine
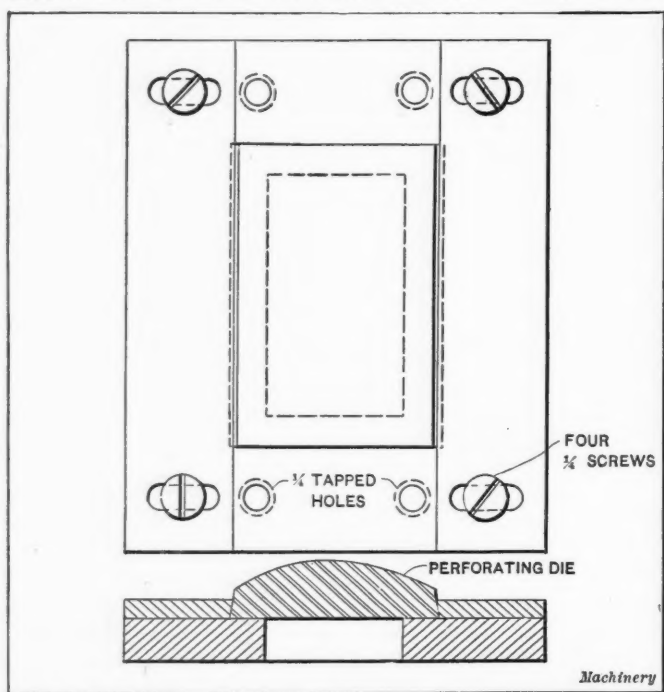

Fig. 16. Device for Holding Perforating Dies while Filing

while it is being filed out. The device shown is adjustable to accommodate various widths of dies.

The most essential points to be remembered when filing out a perforating die are: Use a coarse file for the rough filing and finish with a smooth one. Take care to have the clearance filed straight in order to prevent the congestion of scrap punchings in the die; perforating dies as a rule are not very strong and are often cracked and broken because of neglect on this point. The clearance should not be filed over 1½ degree, in order to make the die as strong as possible; in cases where the holes in the dies are close together even less clearance is necessary, and a very narrow wall that separates two holes is filed almost straight on each side, with just enough of a taper to clear. Care must be taken when filing to prevent the back or the sides of the file from running into that part of the die that has already been finished.

Making the Punch for a Perforating Die

The punch used with the die shown in Fig. 8 is comparatively simple in its construction. It consists of the usual form of punch-holder into which the two perforating punches are driven. The star-shaped punch, after it is fitted to the die and hardened, is driven into the punch-holder in such a position that when it is entered into the die the sides of the punch-holder will be in a straight line and parallel with the die-bed. The tools are then set up in a hand or foot press so that the die and star punch are in proper alignment with each other. The foot treadle of the press is then disconnected from the gate so that the gate which holds the punch-holder in place can be withdrawn from the press without

disturbing the punch-holder or the ways upon which the gate slides. The other punch, in its unfinished state, is then driven into the punch-holder and the face is coated with a 1/16-inch thickness of soft solder. The gate of the press is then slipped back into place and the impression of the outline of the die is transferred to the solder on the face of the punch. The punch-holder is then removed from the press and the punch driven out and milled to conform to the soft solder outline of the die, after which the punch-holder is put back into the press, care being taken to see that the star-shaped punch is in proper alignment with the die. The milled punch is then put back in place and gradually sheared and fitted to the die. Each time after the punch has been lightly sheared into the die, the fins and surplus stock are removed and the punch is again entered and sheared a trifle deeper, until it enters the die at least ¼ inch.

The hand or foot press is very convenient to use when fitting perforating punches to their dies, because the construction of the press makes it possible to handle the gate conveniently and to keep the punches in proper alignment with the die.

In making perforating punches such as shown in Fig. 14, the punch-holder is first machined to the desired shape and size, after which the taper hole for the shank of punch A is reamed. The shank of the punch is then turned and fitted to the punch-holder and driven into place. The face of the punch is made to conform to the outside diameter of the shell and is then clamped to the face of the die and the outline scribed on it, after which it is milled to shape and sheared and fitted to the die. Before scribing the outline of the die on the face of the punch, care must be taken to see that the punch is set in the proper relation with the die, so that when the finished tools are set up in the press, there will be no necessity for elongating or widening the slots in the die-bed used for clamping the die to the bed of the press, due to the punch not being laid out central with the die.

After the first punch A has been fitted to the die, the holes for the other three punches are laid out so that the cutting part of the punches will be as nearly central with the shanks as possible. Holes are then drilled and reamed for the shanks, and when this is done punch A is hardened. The reason that this punch is hardened before the other punches are fitted to the die is that if the punches were all sheared and fitted together and then punch A should spring in hardening, it would cause great difficulties in again bringing the punches into proper alignment with the die. After punch A has been hardened and driven back into the punch-holder, the shanks of the other three punches are turned up and fitted to the respective holes into which they are afterwards driven. The shanks of these punches may be made either straight or tapered, but should be a good driving fit and should have shoulders bearing against the punch-holder.

Before the punches are driven into place, the die and punch A are set up in the foot press and properly aligned with each other. The gate of the press is then withdrawn, the three punches are driven into place, and the faces coated with soft solder. The gate of the press is then slipped back into place and the outline of the die transferred to the punches, after which they are driven out and milled separately in the milling machine. Sometimes the punches cannot be driven out from the back of the punch-holder, because if the holes for these punches were drilled through they would run into and weaken the shank of the holder. In such cases holes are drilled from the side to meet the shank holes, in order to allow a taper drift to be used for starting the punch so that it can be removed.

After the punches have been milled, they are driven back into the punch-holder and are sheared and fitted into the die, as previously described. The punches, of course, are lined up perfectly with the die so as to enter into their respective holes as one single punch. After the punches are hardened they are sharpened by holding the punch-holder in a special grinding fixture and drawing the punches back and forth across the face of a wheel of about the same diameter as the shell to be perforated. It will be seen in Fig. 14 that the base of the punches is strengthened by milling the punches so that there is a liberal fillet between the shoulder

of the punch and the milled-out shape. This also tends to prevent distortion in hardening.

The Stripper

The stripper serves three purposes: it strips the metal from the punch; it supports the small punches by preventing them from springing; and it tends to keep the perforated shell in shape by preventing it from bending or becoming "kinked up." The commonly used stripper construction is shown in Fig. 15. The face of the stripper conforms to the outside diameter of the shell. It is drilled and worked out so that it is a sliding fit on the punches. The shoulder part of the stripper bears against the bottom lugs of the side pieces A and B, which are fastened to the punch-holder and prevent the stripper from being forced off the punch. Six spiral springs exert the required pressure on the stripper. When setting up the tools in the press, the stripper is forced back about ⅛ inch and two pieces of, say, No. 31 drill rod are placed between the stripper and the bottom lugs of the side pieces, which keeps the stripper out of the way while the punch and die are aligned with each other.

In conclusion, it may be mentioned that perforating dies of the type described are sharpened on universal grinding machines. Owing to frequent sharpening it is sometimes necessary to raise them slightly by putting shims of sheet steel under the dies. These shims are drilled and filed out to conform to the holes in the dies, in order that the scrap punchings may drop through.

* * *

REPAIRING AN OLD LATHE IN NEW ZEALAND

By JOHN PEDDIE*

An article recently appeared in the pages of MACHINERY on the repair of machine tools.† In many shops, unfortunately, tools such as treated of in this article would not be considered in need of repairs. This, however, could scarcely be claimed for the lathe which the writer recently overhauled. It is
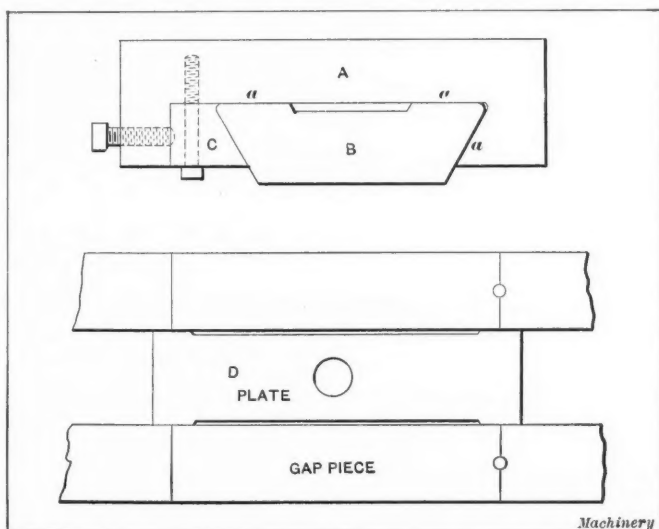

Fig. 1. Diagrammatical Outline of Slide and Gap Piece

not necessary to go into the reasons for repairing such a tool instead of breaking it up for scrap and buying a new one. This lathe had a 15-foot bed and swung 18 inches. It had a gap which, when used, allowed a swing of about 3 feet. The gap piece was fitted in such a peculiar manner—bedded down on roughly clipped projections, and held in line with a couple of similarly fitted pins—that one might suppose it had been specially built to bring the gap lathe to discredit.

It was resolved to have the bed planed. Before doing so the gap piece was bedded down solidly on the four corners, and a cast-iron plate was made to fit between the shears, as shown at D in Fig. 1. It is about 1 inch thick and fits tightly for about ¾ inch on each side of the joints, these being scraped to make a good bearing, and tight enough to require it to be tapped into place with a wooden mallet. The hole

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† See MACHINERY, July, 1911, "Repairing Lathes and Milling Machines."

in the center admits a spanner for bolting down the gap piece.

After planing, the bed was leveled up as well as possible with an accurate level. Having no straightedge of the required size to test it with, it was assumed that the planing was accurate enough for our purpose.

The saddle on being tried on the bed proved to be worn bell-mouthed. Fig. 2 shows a diagrammatical plan of the saddle. The writer concluded that it would run longer without developing this defect if it had the bearing cleared away in the center. Accordingly the center bearing part was cut away with hammer and chisel to a depth of 1/16 inch, as shown by
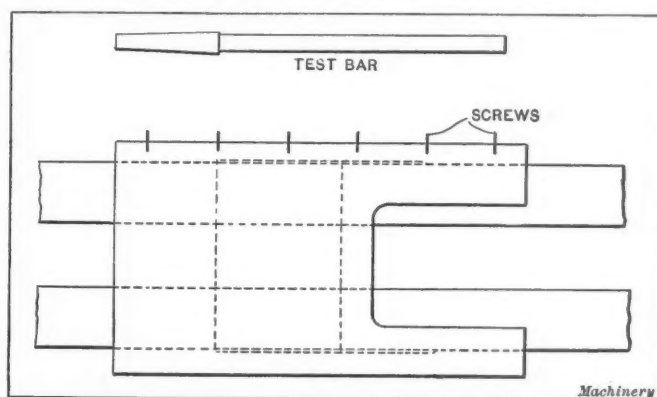

Fig. 2. Test Bar used for Lining up and Diagrammatical Plan of Saddle

the dotted lines, leaving a bearing of about 6 inches at each end. This bearing surface was then filed and scraped to fit the bed. The bed was also scraped from end to end, in this case merely removing the roughness left by the planer tool.

The saddle, as indicated, has a number of screws for setting up the gib. A careful man may be able to keep these correctly adjusted, but the arrangement cannot be compared with the taper gib for convenience and certainty, even though the latter does wear more at one end than the other. Any defect in adjustment of this type allows a rocking motion of the saddle which is shown if one takes a light cut alternately with the right- and left-hand feed without altering the adjustment of the tool.

The refitting of the slide-rest was next undertaken. This was a compound rest bolted to the saddle and removable when
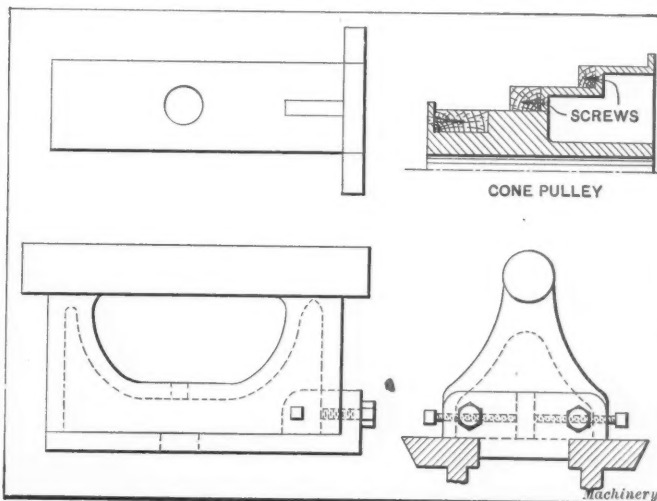

Fig. 3. Tailstock Adjustment and Cone Pulley after Improvement

the latter was required for boring. A 12-inch surface plate was available for this part of the work. The upper part of Fig. 1 shows a section of one slide. The order of operations was as follows: Faces a of part B, and the bearing face of gib C were first scraped to the surface plate. Part A was then scraped to fit B on the true faces. Gib C was then screwed into place and gradually set up while the corresponding face of B was scraped to fit until the slide would move with equal tension from end to end and show good contact. On these old slides, the sharp front edge which when new serves so well to keep the slides clear of grit, is worn away, leaving a slight wedge-shaped opening which offers every facility for the admission of dirt. A brass scraper was fitted at the front of the

saddle to keep the ways clean; this worked well until it got frayed through running over the joint at the gap.

The centers of this lathe were about 2 inches long, and with a taper so abrupt that it was almost impossible to get them to hold in their sockets for turning up the points. The sockets were, therefore, bored out to a Morse taper, a taper plug gage and test bar, as shown in Fig. 2, having first been made. The number of lightest possible cuts required to get these holes true is quite remarkable to one not used to this work.

Machinists who are accustomed to lathes which are without the set-over tailstock are familiar with the trouble of setting the lathe to turn parallel between centers and at the same time to bore parallel. This lathe had no set-over, but the base-plate shown in Fig. 3, which accomplished that end, was designed and fitted. The plate fits between the shears for its whole length, and is secured to the end of the tailstock by ¾-inch set-screws. In fitting this, the test bar was used in the tailstock center socket, and tests made by an indicator in the toolpost, in order to make the spindle parallel with the bed.

The alignment of the headstock spindle was next under-taken. The test bar showed that this was worn down at the front bearing. As the bushes were of gunmetal, in halves, set in rectangular pockets, these were adjusted by soldering a piece of sheet brass on the under side of the front bearing, and then the under side of both bearings was filed till the test bar showed that the adjustment was correct. At the same time any necessary scraping was done on the bushes to secure a good bearing. The front bearing was left slightly high to allow for future wear.

The cone pulley of this lathe had four steps, the smallest being so small as to be of scarcely any use. It was decided to make it into a three-step pulley, to enable the use of a wider belt. This was done by fitting segments of wood onto the cone as shown in Fig. 3, securing them by screws. The segments and steps were well painted with white lead paint before tightening the screws. The pulleys were then taken to another lathe and turned up. The increase in pulling power obtained was very noticeable and more than compensated for the smaller range of speeds. The difference in the class of work obtainable from this lathe before and after the repairs was, of course, very great. Little more than the barest essentials for obtaining true work was attempted, and many minor details might have been corrected had opportunity offered. In most cases it would hardly pay, however, to fix up an old tool in the manner indicated.

* * *

INTERESTING DEVELOPMENT IN HIGH-EFFICIENCY GENERATORS

In speaking before the American Society of Swedish Engineers, Brooklyn, N. Y., on "Generating Apparatus used for Wireless Telegraphy and Telephony," Mr. E. F. Alexanderson, of the General Electric Co., Schenectady, N. Y., described an interesting type of machine which he has developed for obtaining very high frequencies. In the generator described, a steel disk resembling the rotor of a steam turbine and having six hundred slots, is used. This steel disk rotates with its edge between the pole faces of the stator, at a speed of 20,000 revolutions per minute. Brass plugs are riveted into the space between the steel teeth in order to reduce the air resistance. The diameter of the steel disk is 12 inches. The generator is driven from an electric motor by gearing similar to that used for reducing the speed in De Laval steam turbines, except that in this case the gearing is used for increasing the speed. With this machine it is possible to obtain 100,000 alternations per second and with the aid of a special winding and 800 polar projections on the disk, 200,000 alternations per second have been obtained. High-frequency generators of this type will probably prove especially valuable in wireless telephony, the success of which depends largely upon the possibility of producing currents of high frequency. The development is also of great value in the wireless telegraphy field as it makes possible the sending of messages over greater distances, and also provides a means for non-interference with other wireless apparatus, as it is possible to tune the various instruments so as to receive only certain messages, in a way not possible with the lower frequencies produced by the spark system.

SOME TOOLS USED IN THE MANUFACTURE OF SMALL STEEL BALLS*

By A. G. BLACK†

Very small steel balls—say of from 1/32 to 1/16 inch in diameter—are handled in a somewhat different manner when being manufactured than are the larger sizes. The reason for this is simply that more delicate machinery is required on account of the small sizes dealt with. The best idea of how small a 1/16-inch ball really is may be gathered from the fact that there are 28,840 balls of this size to a pound, or about 1800 balls to an ounce. Comparing this with 1/2-inch balls, we find that there are only fifty-five in a pound, or less than four in an ounce.

In the following will be described the methods that were used in a factory with which the writer was connected several years ago, for making balls of small sizes.

The forgings were made from annealed crucible steel wire, the diameter of which was about 0.002 inch smaller than the diameter of the finished ball. The stock was upset enough in the forging operation to make the blank about 0.010 inch
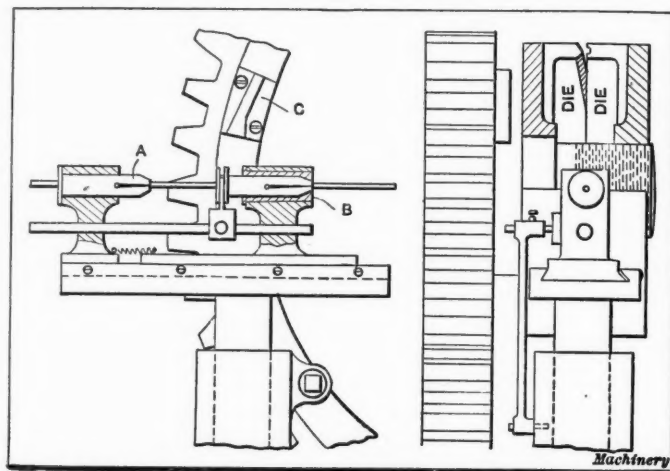

Fig. 1. Diagrammatical Outline of the Main Features of the Ball Blank Rolling Machine

larger than the finished ball. The forgings were made in a Simonds forging machine, of the same general type as described by Mr. Grant in the February number of MACHINERY, in the article entitled "The Manufacture of Steel Balls." The machine was remodeled, however, to use the platen style of die as shown in Fig. 1, this being accomplished by cutting off the extending projection on the large driving gear and mounting one-half of the circular die on the hub of the gear, the other half being mounted on the shaft that projected through the center of the hub and revolved in the opposite direction. A gas jet was located near the point on the dies where the stock entered. In this way the stock was heated to the required heat for rolling.

The wire was furnished in a coil and fed off from a reel, an automatic feeding device being provided having one stationary, spring chuck A, Fig. 1, and one sliding spring chuck B, similar to those used on automatic screw machines. A cam C was provided on the side of the main driving gear to open and close the sliding chuck. When the stock fed into the dies, the cam opened the chuck and also carried it back against the action of a spring for another feed, and locked it ready for the next cycle. The stationary spring chuck held the stock from moving while the rolling operation took place. The machine could cut off and roll 75,000 blanks per day.

After the forgings were made, the blanks were passed between two large hardened revolving plates in order to remove any fins or inequalities in the blank. They were then hardened before grinding, which latter operation was done in a machine similar to the dry grinder described by Mr. Grant, except that the machine was smaller. The writer also added an improvement which consisted of a spring suspension of the upper ring which rotated the balls as indicated in Fig. 2. Four coil springs A were mounted between the upper ring

and a plate above it as shown, the upper ring being driven from this plate by four stud bolts. In this way it was possible to place any amount of pressure required upon the balls. With this arrangement the emery wheel and the rings would last much longer, because of the reduction of wear, as the upper ring was allowed to spring away from the wheel when a new set of blanks, which were not absolutely round, were first put into the grinder.

Another improvement consisted in making an adjustable emery wheel fastening for preventing the emery wheel from running out of balance, due partly to the inequalities of the wheel itself and partly to the wear of the spindle bearings.
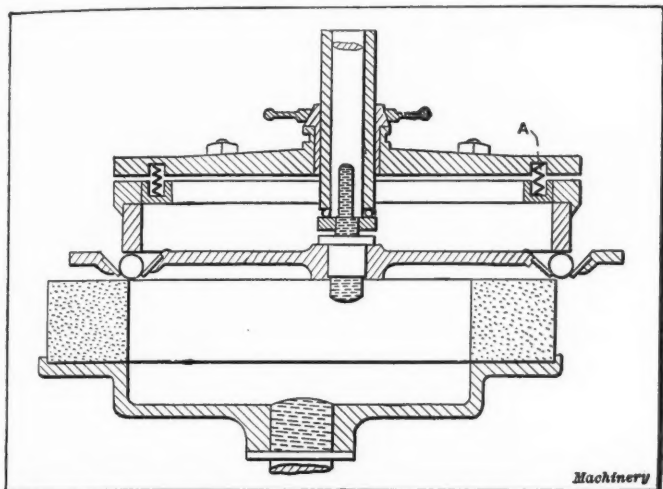

Fig. 2. Spring Balanced Dry Grinding Machine

An arrangement was introduced consisting of four wide jaws in the wheel plate, as shown in Fig. 3, which gripped the edge of the wheel in a manner similar to that of a lathe chuck, but which had surface enough to cover a fair portion of the wheel diameter. In this way, the wheel could be adjusted and balanced every time a new wheel was mounted.

The balls were dry ground to within 0.002 inch of the finished size, after which they were lapped with emery and oil, using a set of cast-iron rings. These were fitted to sensitive bench drill presses arranged in banks of six, attended by one operator. After the oil finishing grinding, the balls were polished and inspected. This last operation was done by an auto-
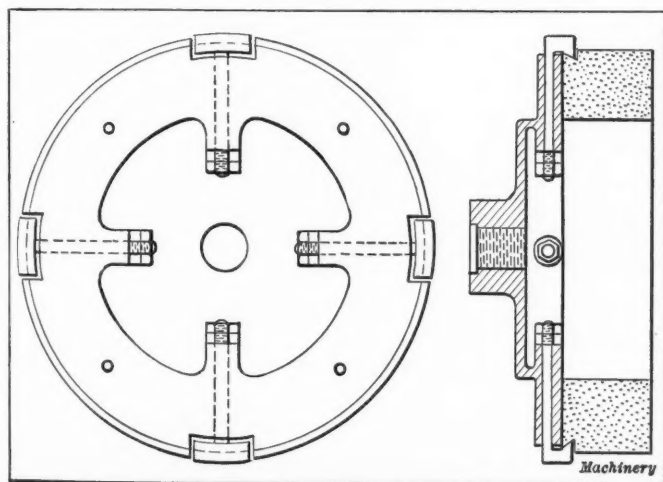

Fig. 3. Faceplate and Chuck-jaws for Holding Grinding Wheel

matic device which the writer designed and built, the outlines of which are shown in Fig. 4.

The principle of this machine was to feed the balls from a hopper under a fixed magnifying glass about 2¾ inches in diameter, focused to suit the operator. The balls would then remain under the glass for six seconds. The operator held a steel magnet in each hand, and with her elbows or arms resting on the table at each side of the glass lens, was ready to pick out any balls which appeared defective to her. If they were all perfect, she would merely wait until the balls turned half a revolution, exposing the other half for six seconds more. Then, in order to expose the periphery whch had not yet been directly under the inspector's view, the balls were turned

one-quarter of a revolution so as to bring the part but imperfectly seen in the two previous operations squarely under the glass; then another half turn was made and in that way all the parts of the balls were exposed and could be carefully inspected. After this, the feeding plate would draw out from under the glass and the balls would fall into a drawer, after which the plate would be returned to the hopper, bringing out another lot of balls ready to be inspected. This last operation required also six seconds, which gave the operator an opportunity to temporarily rest her eyes.

The various movements were timed by a cam. When changing from one size of ball to another it was only necessary to slip off one cam and put in another adapted for the desired size, and also to change the feed plate. The device permitted of inspecting balls ranging in size from 1/16 to 1/2 inch diameter. The method was very efficient and six girls were able, in this way, to handle the work which required twenty inspectors to do in the old way. The method was also more positive, and the chances of defects slipping by the inspector were not as great, as each ball was fully exposed to view from all sides.

Some of the cam motions mentioned, as, for instance, that for feeding the balls from under the hopper, were constant
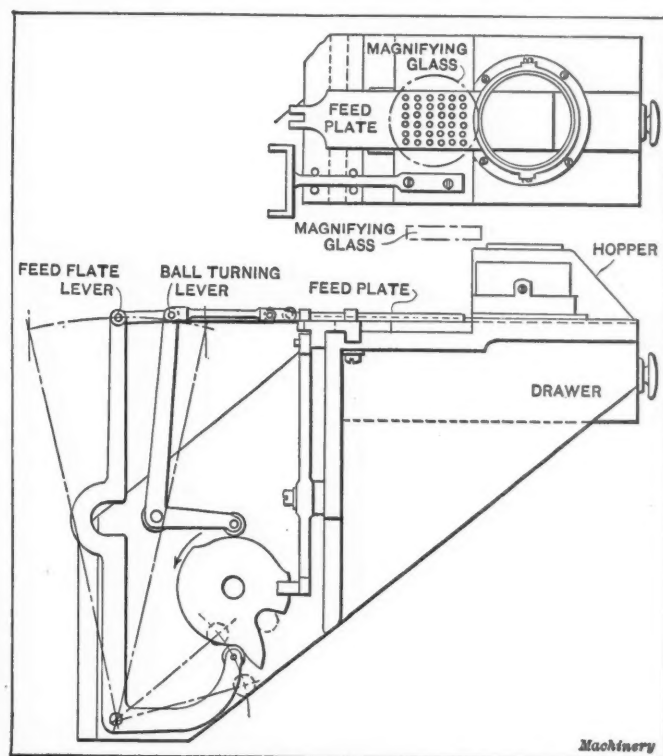

Fig. 4. Main Features of Ball Inspecting Machine

for all sizes of balls, but the cam operating the sliding plate that rolled the balls over was different for different sizes, as the plate had to travel further for the larger balls than for the smaller. The lens of the magnifying glass was large enough so that one could see 64 one-quarter-inch balls conveniently, and as there were often but one or two of these balls to be picked out at each movement, the operator had plenty of time, and with both hands free could pick them out very rapidly. A lever was also provided to throw out a clutch mounted on the driving pulley hub, so that the operator could stop the machine immediately, if necessary.

One difficulty that had to be overcome consisted in the balls clogging and refusing to roll out from a small opening. This difficulty was overcome by bridging over the outlet by a partial baffle; then the balls would easily feed out in the shallow depth under the bridge where they were always free to roll out and drop down an incline. This prevented clogging and no agitator was found necessary. The device was never patented because the president of the concern with which the writer was employed believed that if a patent was applied for the principle would become known to all ball manufacturers, and they would work out the same idea in a somewhat different manner. The gaging was done by a machine similar to that illustrated by Mr. Grant.

ON WRITING TECHNICAL ARTICLES

SUGGESTIONS ON THE PREPARATION OF CONTRIBUTIONS FOR MACHINERY

Comparatively few of the manuscripts submitted to the editor of a technical journal are from writers who are familiar with the actual requirements. This general lack of information on the part of contributors regarding the selection of a subject, its treatment and the many little things about it that go to make up a desirable article from an editorial standpoint, often results in a waste of time and effort, diminishes the chance of the contribution's being accepted and makes necessary a considerable amount of editorial revision with a consequent delay in publication. The object of this article is to give some general information which the contributor may advantageously use as a guide in the preparation of manuscripts for technical magazines.

Choice of Subjects

The writer should choose for the subject of his contribution, some form of engineering or research work with which he has had experience. The more experienced he is in the class of work described, however, the more careful should he be not to assume too much knowledge of the subject on the part of his readers. He should not neglect to explain simple points, particularly if his trade is a special one and its methods not generally known to the mass of mechanics. A thorough reading of one or two issues of the journal to which the article is to be submitted, will generally show the perspective limitations of its readers.

It is well to bear in mind that the kind of material most acceptable to a technical journal is that which has not yet found its way into the text-books, nor has become common knowledge in the profession and schools, but which has all the earmarks of getting there at a later date. Wherever engineering work is being done by a new and better method, or with new and better tools, machines or appliances—in short, wherever progress is evidenced—there is material which every intelligently conducted technical journal is glad to publish. Long articles do not receive more consideration or are not more likely to be accepted than short ones. Each must be judged on its own merit.

On Choosing Titles

The title of the article should be short but expressive of its contents. If the nature of the subject is such that it is difficult to do it justice in a title of a few words, it is advisable to use a key-word title and supplement this with a sub-title, thus:

MOTORS FOR AEROPLANES
Their Selection, Operation and Maintenance

The introductory paragraph should also be brief. It should state what the article is to treat of, the object of the device or method to be described, and should point out any original or striking features likely to prove of interest. An article having a single purpose will generally prove much stronger than one in which the reader's attention is divided. For example, this article is stronger on account of being confined to engineering magazine contributions than it would have been had an attempt been made to treat the subject with respect to all classes of magazines and books. The points laid out in the introductory statement should be kept thoroughly in mind throughout the writing of the article.

Treatment of the Subject

Next in order comes the general treatment of the subject, which should form the body of the article. Make the sentences short and clear, and the statements exact and free from ambiguities. Do not, however, attempt to be brief at the expense of correctness and accuracy of expression, but cut out every adverb, adjective and qualifying clause which can be spared. Avoid "flowery" language. It is all right in popular magazines, but hardly suitable to magazines devoted strictly to practical mechanics.

An article need not lack literary style because of the elimination of extraneous expressions and words, the meaning of which one has to hunt for in the dictionary. Express each thought, so far as possible, in a sentence by itself, having the subject as near as practicable to the beginning of the sentence. Do not be afraid of using the same words over and over again, if repetition is conducive to clearness. It is more important that a technical article be absolutely clear than that it be perfect from a literary standpoint. When uncertain as to your grammar or phrasing, rewrite the sentence rather than waste time tinkering with it.

If a device for performing certain work is to be described, always describe the work to be done first before taking up the details of the device. Do not bring in matter extraneous to the subject treated in the article. Tell all there is to be told about the subject treated, and then if there is something to be told about some other subject, write another article.

Concerning Style in MACHINERY

In general do not use symbols such as ' for feet, " for inches, and # for number; it is better to write the words, because ' signifies minutes as well as feet, " seconds as well as inches, etc.

Use figures for all numbers from 100 up. Spell out all numbers less than 100, except when used as a dimension, sum of money, percentage, or where followed by a fraction, by an abbreviated dimension, or by one or more numbers above 100 in the same sentence. Spell out all numbers when used at the beginning of a sentence.

Use "by" instead of $\times$ in giving dimensions.

All decimal numbers having no units should have a cipher placed before the decimal point, thus, 0.26 feet, and not .26 feet.

Separate whole numbers of more than four figures into threes, by a comma, thus, 10,000. Do not use a comma in numbers of four figures. Do not separate decimals into threes.

Write time of day in figures, with a colon between, thus, 7:30 o'clock. Capitalize A. M. and P. M.

Use numbers indicating per cent, and spell rather than symbolize "per cent," thus, 16 per cent, and not sixteen %.

In tables, when necessary to abbreviate, use the singular form thus, 15 in., and not 15 ins., but, as a general rule, use no abbreviations except those especially mentioned below. Do not abbreviate the name of a month when followed by the day of the month, but write out in full, thus, November 30, omitting the th, st, etc. Abbreviate the states when used after cities, thus, Brooklyn, N. Y. Omit No. or # before the number on a street, thus, 36 Fulton St. Abbreviate "Company" to "Co." "Company" is always singular, but "Works" are plural. Abbreviate "Manufacturing" when part of firm name, as Brown & Sharpe Mfg. Co. Also write Fig. 1, and not Figure 1.

Capitalize the sections of the country, thus, North, Northwest, etc. Do not capitalize the seasons, such as summer, winter, etc. Personal titles should not be capitalized: write John Jones, electrical engineer. Chemical symbols such as H_2O, etc., should always be capitalized. The "F" in "Fig." should be a capital.

Use "&" in titles of firms and corporations, and in names of railways, but not elsewhere, thus, Yale & Towne Mfg. Co.

Spelling, Punctuation and Mathematical Formulas

Correct spelling is a matter that any contributor with a dictionary at hand can settle for himself. As to punctuation, the general rules are so well known that there is no need to dwell upon them here, aside from cautioning the writer to use the points sparingly, especially the commas, and to enclose in quotation marks sentences and paragraphs taken bodily from other articles or books. Do not use quotation marks around reference letters. Underline as few words as possible; rather construct the sentence to give the required emphasis.

When it is necessary to include printed forms or blanks for illustrative purposes, and they are of such size and elaboration as to entail considerable expense to set up in type and rule, it is much better if they are sharply defined and well printed, to treat them as illustrations for direct reproduction. In this case, the original dimensions should be stated in the text or in the title of the engraving.

Do not bring in more mathematical treatment in an article than absolutely necessary for a clear understanding of the subject. Some writers seem to think that formulas make an article look "learned" and therefore more acceptable. Where mathematical or algebraic expressions such as formulas, equations, etc., are necessary, they should be clearly and carefully written in with a pen. A carelessly written formula confuses

the compositor and leads to typographical errors. Check all mathematical calculations so as to be sure that they are correct. Many writers seem to depend upon the editors for checking, with the result that the editor, finding an error in the calculations, concludes that the article is unreliable and returns it. An error of judgment and opinion is excusable, but an error in simple arithmetic is unpardonable. When isolated letters referring to mathematical expressions or to an illustration are used in the body of the text, they should be underscored.

Summing up in Conclusion

Following the body of the article, there should be a general statement showing how the preceding treatment of the subject has demonstrated what the writer set out to show, as stated in the introductory paragraph. Finally, there should be given a condensed summing up, so worded that a brief glance will enable a casual reader to grasp the substance of the article and decide, without reading it throughout, whether he desires to examine it in detail.

General Notes on the Preparation of Articles

After writing an article, it is a good plan to lay it aside for a few days and then reread it. There will then often be found statements that can be better phrased and words that can be replaced by others which will more clearly express the ideas to be conveyed.

Number the sheets consecutively in the upper right-hand corner. In case it be necessary to insert any considerable amount of additional matter in a part of the manuscript already written, this matter may be written on a separate sheet which should be given the same page number as the sheet it supplements, together with an index letter, thus, "7A", "7B", etc. These sheets should be marked to indicate exactly where they are to be inserted, thus, "Insert at A, page 7", and the position of "A" should be indicated on page 7.

The writer's name and address should be placed at the bottom of the last page of the manuscript. If the writer does not wish his name to appear as author, he should write opposite his name "Not for publication," and give the nom-de-plume to be used instead.

The general appearance of a manuscript creates a first impression that often carries appreciable weight in the acceptance or rejection of an article. For this reason it is advantageous to have the manuscript typewritten when this can be done without undue inconvenience. Typewritten matter can also be read with a continuity of attention that is difficult to give hand-written manuscripts, however excellent the writing may be, and as this continuity of attention is absolutely necessary for properly estimating the value of an article, it should be the writer's aim to facilitate it as much as possible. Another advantage of having the article typewritten is the ease with which a duplicate (carbon) copy can be made. A duplicate copy should always be retained, in view of the possible loss of the copy sent to the editor.

It should be understood, however, that hand-written articles will always receive proper attention, and no contributor should feel that he must incur the expense of having his article typewritten in order that it may be accepted. The final test of all articles is their technical merit.

The original manuscript should preferably be written by hand with pen or pencil rather than composed on the typewriter or dictated to a stenographer. An opportunity is thus afforded the writer of looking over the first draft, as a whole, and making such corrections and changes as will avoid the necessity for a second typewritten version. Dependence upon a stenographer tends toward repetition and lack of clearness, because, when dictating, a man does not have the opportunity to see what he has said, to note how the statements hang together, nor to cull and collect as he proceeds—all of which is necessary in order that his thoughts be expressed in the best possible manner. While the method of composing directly upon a typewriter is not so objectionable as dictating to a stenographer, it does not afford the same facility for correction as pen or pencil.

The paper upon which the final copy of the article is written should be white and of tough texture to withstand rough usage. It should also have sufficient weight to prevent it from crum-

pling, as tissue or thin paper is likely to do. When a manuscript is received by the managing editor, he may turn it over to one or more readers who are sufficiently acquainted with the subject to express an intelligent opinion regarding the advisability of publishing it. Upon their decision depends to a large extent the fate of the manuscript so far as it relates to the journal considering it. If, therefore, the writer is not certain of having his article accepted, it is specially advantageous to use paper of tough texture because if it be rejected and returned, the writer will naturally submit it to other journals, and if poor paper is used, the article may then have to be rewritten.

Sheets 8 by 11 inches should preferably be used, leaving a margin about an inch wide at the left-hand side between the edge of the paper and the writing. Write only on one side of the paper and allow a full quarter inch between the lines of the manuscript, whether written by hand or machine. No matter how well the article is written, each magazine has a certain style of its own which the editors follow, and minor changes are therefore necessary. After all the sheets of the article have been written, arrange them in numerical order and clip the sheets together. Do not pin, bind or sew them, as this is troublesome to those who handle the sheets.

As a rule, do not write articles to suit illustrations. Frame up the article first, and then make the drawings and take the photographs which are necessary for making a clear presentation of the subject. When the sketches and photographs are ready, it is a good plan to rewrite the article, basing it upon the original framed-up article and adding such information as may be suggested by the illustrations.

Copy for Illustrations

Use illustrations liberally. Nice drawings add to the value of the article. In making drawings use a separate sheet for each one and write your name in the lower right-hand corner. A clear lead pencil drawing, with sharp, well-defined lines, is all that is necessary for ordinary reproduction. Good blueprints, original drawings or tracings are also generally satisfactory for reproducing by the so-called wax-engraving process. Finely executed drawings are not essential; but only when time, skill and drafting materials are lacking to make a finished drawing, should rough pencil sketches be submitted.

When drawings are intended for direct reproduction—that is, to be photographed directly for use in the columns of a journal—they should be made in black ink on bristol-board, heavy smooth paper, or tracing cloth. First decide upon the space the figure will occupy on the printed page and make the drawing about twice this size. There will then be ample space to make the details clear and the imperfections in the drawing will be much less noticeable in the reduction, so that the printed effect will be more pleasing to the eye. Make the drawing first with a hard lead pencil, and then go over it with ink, making the numerals and reference letters about twice the size and thickness they are to be in the reduction. Use only black ink, because red and most other colors will not reproduce. In order to see how the drawing will appear when printed, look at the sketch through a reducing glass or a pair of ordinary opera-glasses with the large lenses held to the eyes. Corrections or changes may be indicated on the drawings by using a blue pencil, as markings in blue will not show up in the reproduction.

It is important to bear in mind that any illustrations intended for direct reproduction, such as original drawings or tracings, must not be folded. Original drawings can be sent protected by paper flaps pasted over them, and should be enclosed between stiff card-boards. Tracings should be rolled and sent in mailing tubes. Blueprints which cannot be used for direct reproduction, and pencil drawings, may be folded.

Don't make three or four drawings if all the information can be given just as clearly in one or two. Generally a plan and elevation show everything required. Use the "third angle of projection," and show all the parts of a device in their proper relative locations. Be sure that hidden parts are indicated by dotted lines if necessary to show the construction clearly. Use shade lines according to the rules of mechanical drawing. A shaded drawing is more easily comprehended than one that is not shaded. Do not use shading, however, to indicate curved surfaces.

In selecting photographs, or making photographic prints for illustrations, give preference to those which are sharp and clear with the proper contrasts of light and shade. The best reproductions are made from glossy silver prints of a slightly reddish tone and not too dark. Glossy velox prints reproduce very well by the halftone process, and being printed by gaslight are often furnished instead of sun prints when the weather is cloudy and time cannot be spared to wait for sun prints. Do not put reference letters directly on photographs. If the various parts of the object illustrated on the photographs need reference letters, lay a piece of tracing paper on the photograph and trace the outline of the picture. Then put the reference letters on the tracing paper in the exact place where they ought to appear on the photograph. Use capital reference letters in preference to small letters. Care should be taken not to write figure numbers, titles, etc., with a hard pencil or with ink on the back of an unmounted photograph; otherwise, the pencil marks will be embossed on the face of the print and the ink will soak through when the photograph is mounted, injuring the copy for reproduction. Either write lightly with a soft pencil on the back of the print or have the photograph mounted and write on the back of the mount. As in the case of drawings, the writer's name should be written in the lower right-hand corner of each photograph.

Make a single package of the manuscript and illustrations, keeping the sheets of the former flat if possible. Either mail or express the material to the editor, and under separate cover, send a letter advising him of the fact and stating concisely the purpose and scope of the article. Ordinarily, it is safer and better to send bulky material by express, especially if there are mounted photographs in the package, because in case of loss or misdirection the material can be more readily traced.

Payment for Articles

Contributions published in the leading technical journals are generally paid for, usually on some space rate basis. The prices paid for contributions differ with the journals and character of the contributions. In general the rates vary from $5 to $8 per 1000 words. In fixing the rate paid for a contribution the editor takes into consideration the probable value of the article to his readers; the labor incident to its preparation; and the expenses that have been incurred in obtaining photographs. Obviously, an article containing many mathematical formulas and calculations requires more time and care in its preparation than one purely descriptive of a machine or process. On the other hand, the description of a machine may include a photograph, or photographs, to illustrate, which have meant some expense to the contributor. The space filled by text, tables and illustrations of articles published in MACHINERY is all figured at the same rate.

Exclusive Contributions

Contributions submitted for publication in MACHINERY with the expectation of payment are accepted only for exclusive publication. A contributor who sends the same articles to other journals will have his offerings rejected if the fact becomes known to the editor; if an article is published and it becomes known that it was sent to other journals, payment will be withheld or its return demanded. Unless other arrangements are made, the purchase of an article for MACHINERY includes all rights of publication.

Character of Desirable Articles

Among the matter acceptable for publication in MACHINERY are tables of data suitable for the Data Sheets, especially when accompanied by articles; articles on new developments in machine shop practice, machine shop methods and machine design, especially when illustrated with photographs and drawings; articles with photographs or drawings on lathe, planer, milling machine and screw machine work, punch and die work, safety devices, lapping, scraping and fitting, laying out work, drafting-room methods, etc. Unusual methods of machining large castings and making repairs on machinery are generally interesting, and should be illustrated with photographs whenever possible.

Why Manuscripts are Rejected

In the course of a year the editors read several hundred manuscripts, and many are rejected for various reasons, among which are: the articles are badly prepared or poorly illustrated; the conclusions are erroneous or at variance with generally accepted good practice; the subjects are not of general interest to the readers of MACHINERY; or many similar articles have been published in recent numbers.

In case the article is not accepted, it will be returned to the writer. He should not, however, be discouraged, because the rejection of a manuscript does not necessarily mean that the article is not worthy of publication. It may be that the subject would not interest the readers of that particular journal, or on the other hand, that it has already been fully covered in previous articles; then again, that particular journal may have an abundance of material on hand that would make it unwise for the editor to accept more.

Articles on machine design which merely review common methods of analysis found in textbooks are not generally acceptable. Periodicals should publish records of advance of the science which they represent, and for that reason be somewhat in advance of the records in textbooks.

Correcting Proof Sheets

After an article is accepted and put into type, the writer may be asked to read the proofs, mark on them any correction or changes he deems necessary and return the proofs O. K'd. to the editor, as soon as possible. In reading proofs, it must be remembered that they are to be gone over mainly for the purpose of seeing that the author's idea is accurately and correctly expressed. Such corrections as wrong spelling, punctuation, etc., can be left to the proofreader. In making these corrections on the proofs, proofreaders' marks may be used because they save some time, but those unaccustomed to their use should simply cross out the erroneous matter and write the correct expressions on the margins of the proof sheets, using lines as leaders to show where the new matter is to be inserted.

Be sure that you have said all that you want to say when the article is first sent. It is annoying to the editor and not creditable to you if you add whole paragraphs or even sentences when the article is submitted to you in type. If, however, through oversight on the part of the author in writing the manuscript, or of the printer in setting it in type, an important phrase or sentence has been left out, the writer should endeavor to supply the omission in the proof by adding enough new words to form one or more complete lines; otherwise, the additional matter may make it necessary for the compositor to "overrun" each remaining line in the paragraph involved, and cause considerable labor and expense. If this addition is not easy to make, it is generally possible to find room for the new matter so that it forms one or more complete lines, by taking out words from the neighboring lines without loss to the sense of the article.

The rules and suggestions given in the preceding paragraphs are intended to touch only the high spots in technical writing. The personality and style of the writer thus are not thwarted by iron-bound rules, but simply directed in the proper channels.

While the suggestions here given have been prepared with a special view to the form in which contributions to technical journals should be written, they may be used, in general, equally well as a guide by those who are called upon to prepare papers for presentation before engineering societies and by those who have in mind the compilation of technical matter for publication in book form.

* * *

SURFACE OR FLAMELESS COMBUSTION

The discovery of means for burning explosive gases, that is, gases mixed with air just sufficient for perfect combustion, described in the May number, was, it appears, erroneously attributed to Prof. William A. Bone of Leeds University, Leeds, England. Prof. Charles E. Lucke of Columbia University, New York, described the same process, in effect, in a paper presented before the American Society of Mechanical Engineers in 1901. Prof. Bone's work, which showed the possibility of attaining temperatures from 2900 to 3600 degrees F. on the surface of porous firebrick with great economy of gas, appealed more to the popular mind as having direct application to cooking and heating. Hence the great interest in the idea.

WATCH CASE MANUFACTURE—2

Before a watch case is fitted up, that is, on a hinged case, before the cap, back and bezel are joined, it is necessary to fit and solder the pendant into the case center. The majority of pendants on watch cases are made from rolled-plate in two pieces, but some are made in one piece by a number of successive press operations. The pendant is used for holding the bow and the stem setting mechanism.

The crown b shown in Fig. 8, which is used for operating the setting mechanism, is also made from rolled plate. The press operations on this part have previously been described in the December, 1909, number of MACHINERY, so that a short summary of the most important operations will be sufficient. The first operation is to make a blank and draw it up into a
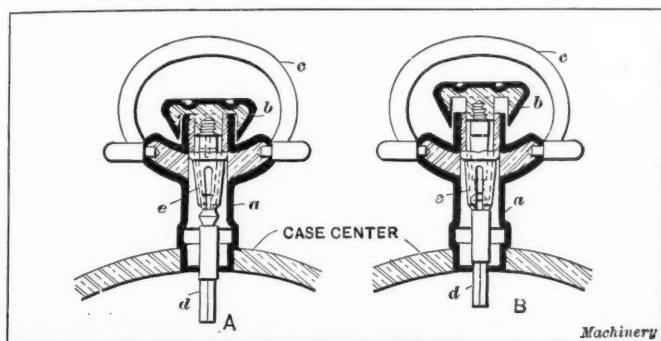
Fig. 8. Pendant Set in the "Up" and "Down" Positions

cup, both operations being accomplished at the same time in a double-action press. This cup is then cut to the desired length in a small sawing machine, after which it is passed through a corrugating die. A core of the required shape, which has been made in an automatic screw machine and corrugated in a die in the punch press, is then inserted and the two parts—cup and core—are placed in a swaging die. The upper part of the die is so formed as to shape one end of the crown, while the lower die forms the other end.

After the crown is completely formed, it is taken to an automatic screw machine where it is counterbored, drilled and tapped to fit the pendant and pendant set. This machine is equipped with a magazine attachment which was illustrated in an article entitled "Magazine Attachments—1," in the February, 1912, number of MACHINERY. This, with the exception of polishing, completes the operations on the crown.

The bow c, Fig. 8, or ring, as it is sometimes called, is made from either solid gold or gold-plated stock, drawn out into wire. Bows made from solid gold are used on solid gold watch cases, and also on some filled cases. The operations followed in making the solid bow are simple and need no description. It might be well, however, to state that it is first blanked from the flat sheet about 1/16 inch thick to approximately the desired shape, then the center is pierced out, and finally, it is completely formed in an embossing die held in a hydraulic press. The flash is then trimmed in a trimming die and the inside ends of the bow milled on a milling machine to fit into the holes in the pendant.

The operations for making the bow from drawn wires are a little more difficult. The material from which the bow is made is first blanked out and drawn up into a cup, and then by successive drawing operations, it is extended to such a length that it can be completely drawn in a draw bench. The drawn wire is then cut up into pieces of the desired length and drawn up in dies. After this operation, the bow is bent around to the desired shape in a simple bending fixture. As bows are generally plain and have no small crevices to polish out, the polishing is very easy.

Construction and Operation of the Pendant Set

On watch cases provided with a pendant set, it is necessary to pull out the crown before the hands can be rotated independently of the motion transmitted to them by the gear train. Some means, however, has to be provided so that the crown cannot be easily pulled out, or the utility of this simple device would be destroyed. This is accomplished by screwing a stem d, Fig. 8, provided with a cone shoulder into the crown, and also screwing a split "chuck" e into the pendant a. Now

before the crown, which is shown "down" at A can be pulled out, the split chuck e has to be expanded as at B, by the cone shoulder on stem d, the necessary pull being sufficient to prevent the setting mechanism from being operated accidentally.

The stem d presses on another squared stem which is used in operating the setting mechanism (see "Setting Mechanisms" in the May number of MACHINERY), and when stem d is pulled out by the crown as shown at B it allows the setting mechanism to operate the hands.

Polishing Watch Cases

A watch case, as a rule, is given a very high polish and is free from scratches and imperfections. The methods employed in polishing a watch case are interesting, and as they differ slightly from other polishing work, it might be well to give a short description of the materials used and the order of the operations. After the case is jointed and assembled, it is rough polished on a rag wheel with dry tripoli, also called "rotten-stone," on it. For additional rough polishing, a hair brush is used and lard oil and tripoli are applied as an abrasive. The second polishing of the inside of the cases is accomplished with an elk skin polishing buff supplied with rouge and alcohol. The outside of the case is polished with a rag wheel and rouge. The center of the case is brushed with a hair brush and hard rouge.

The third polishing is done after the case has been pinned and fitted. The inside of the back and cap are polished with elk skin, soft rouge and alcohol, the outside of the case being

Fig. 9. Hand-operated Engine Turning Machine

polished with a rag wheel and hard rouge. All plain parts and shields are polished with rouge and elk skin, after which an additional polishing is accomplished with soft rouge; then the cases are washed in ammonia water and soap and dried. The drying is done in a heated drying box. After being dried the cases are cleaned with chamois and then sent to the inspector who examines them to see that everything is perfect. The case also passes through numerous other inspections during the course of its manufacture.

Engine Turning

Engine turning, another name for engraving by machinery, consists in cutting various designs or patterns on the backs of a watch case or bezel. Thousands of patterns are cut, and the designs vary considerably. Some types of patterns, of course, require slightly different methods for their production,

and in many cases patterns can only be cut on certain types of machines, or hand engraved. There are at least six distinct types of engine turning machines employed on this work. Three of them, the most interesting ones, will be described in the following.

Hand-operated Engine Turning Machine

The engine turning of the straight-line variety cut in the backs of watch cases is accomplished in the hand-operated machine shown in Fig. 9. The back or bezel, whichever it may be, is held in a chuck A, which, if desired, can be rotated by hand or can be indexed by thumb-screw B. The screw on which thumb-screw B works, has a worm formed on its lower end meshing with a worm-wheel on the head. This device is brought into play when it is desired to cut lines crossing each other at right angles or any other angle.

For producing straight-line work on this machine, the vertical slide carrying chuck A is simply moved up and down by the operator, by means of the hand-crank C. The motion from this crank is transmitted by grooved pulleys, belting and chains to the vertical slide E. This slide is kept in the "up" position by a weight attached to a string F, which runs over the grooved pulleys G.

The table H, carrying the tool-slide I in which the tool J is held, has a circular adjustment, so that the center line passing through the point of the tool is always at right angles to the face of the back being operated upon. This adjustment is controlled by the knurled thumb-screw K, which is rotated by the operator a slight amount after each cut. The tool-slide I is advanced to bring the tool in contact with the work by hand, the operator gripping the spring "handle" L by the first finger and thumb. The depth to which the tool advances into the work is governed entirely by the pressure given to this slide; and it requires considerable experience before an engine turner can produce lines of a uniform depth. It is simply a matter of "fine touch," as no stop is provided for the forward movement of the slide. The slide is returned by a spring which is compressed when the slide is advanced. The work is viewed while under progress through the magnifying glass M.

Various patterns are secured by irregular faced strips N held vertically in the slide O. This slide can be moved to bring any desired pattern into operation by means of a hand-wheel, not shown. The patterns impart an oscillating movement to the head (which is also equipped with a horizontal slide) at the same time that it is moved up and down by the hand-crank C. The spacing of the lines is effected by a pawl and ratchet, not shown, which move the slide carrying tool J along, giving any desired width of spacing.

Electrically-operated Engine Turning Machine

The engine turning machine illustrated in Fig. 10 is electrically operated and is used for producing the "barley corn" engine turning, as it is called. The back that is being engine turned is held in a split chuck A which is tightened on the work by a knurled nut. The entire mechanism is driven from a shaft under the machine, which, in turn, derives power from the countershaft through belting.

The spindle B, which carries the work and is rotated by spur gears from the lower shaft, is mounted in an oscillating head C called a "cradle." This head receives its oscillating motion from a cam held on the lower shaft, which is provided with a series of projections and depressions that impart the oscillations to the head. The "electric pattern" D, as it is called, is driven by spur gears from spindle B. The tool-slide E that carries the holder in which a cutter is retained is also operated from spindle B through spur gears, a universal joint and bevel gearing.

The electric pattern D is made by engravers who cut out the portion to be "barley-corned" and fill the depression with

a non-conductor of the electric current. A steel needle F, under spring tension, runs or is pressed against this pattern and is fed in from the outer circumference towards the center at the same rate of travel that the tool makes across the face of the work, the latter also being traversed in the same direction.

The tool-slide E which is operated in the manner previously described, carries a taper guide which through a roll, lever and crank, forces up the rod G carrying needle F, at the same time as the tool is fed from the outside circumference to the center of the work. This system of levers and cranks constitutes a pantograph arrangement which can be changed to reduce the pattern for any size of watch case. The roll is kept in contact with the pantograph form, so that the motion transmitted to the cutting tool will conform to the shape of the back, by means of a string H to which a weight is attached.

In operation, as the needle F passes over the non-conductor on the pattern D, the electric circuit passing through the armature I is broken so that plate J flies back, and in so doing operates the tool-slide K through lever and crank connections, thus forcing the tool into the work. When the needle F passes over the brass portion of the pattern the circuit is closed and the reverse action is imparted to the tool-slide K, that is, the tool is withdrawn from the work. This
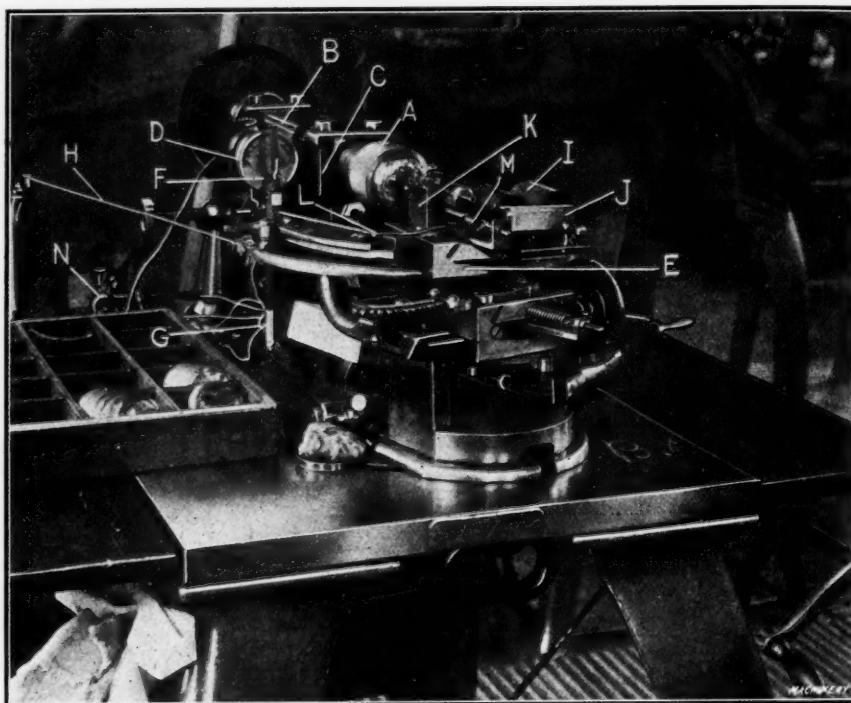

Fig. 10. Electrically-operated Engine Turning Machine

action is repeated until the engine turning is completed, when the machine is automatically stopped.

The tool-slide K is withdrawn to remove the work by a handle L which, when pulled back, brings back the slide and releases it from the tension of the spring M. This spring has sufficient strength to keep the tool in contact with the work, when the electric circuit is broken. The barley-corn effect is governed, of course, entirely by the cam on the shaft under the machine, but the pattern can be made either coarse or fine as desired, by altering the change gears that transmit motion from the spindle B to the main tool-slide E.

Swiss Brocade Machine

The interesting machine shown in Fig. 11 is for "brocade" or "Swiss machine" work, as it is called, which is simply a special class of engine turning resembling in appearance the regular work on currency bills, which is produced by a geometric lathe. This brocade machine was designed and built in Switzerland and is a marvel of mechanical ingenuity. As an engine turning machine its possibilities are practically unlimited, and it is doing away with a large amount of the work previously accomplished by skilled engravers. The work, when being operated on, is held in a split chuck A by a knurled nut. The power for operating the entire mechanism is transmitted from a countershaft by round belting running over grooved

pulleys C, D and E, up to the main driving shaft at the rear, not shown. This shaft drives the front shaft F, which through change gears G operates the spindle carrying the work. This spindle can be centered, that is, located in the desired relation to the other mechanism when starting a pattern, by means of the screw and worm-wheel H; this turns around the sleeve or spindle carrying the work.

This machine is supplied with two pattern plates I and J. Plate I is made of hard rubber and is called the outline pattern plate, while plate J is made of cast brass and is called the filling-in pattern plate. Plate I is rotated by a spur gear held on a shaft at right angles to the rear driving shaft, and is driven from the latter by bevel gears. Plate J is also driven from the shaft which is at right angles to the rear driving shaft, through bevel gears and change gears K.

The faces of plates I and J are provided with the desired patterns and transmit up-and-down oscillating movements to the tool carrier M. The movement is transmitted by steel points held in vertical brackets N (only one can be seen), which are fastened to a dovetail-shaped bar operated by
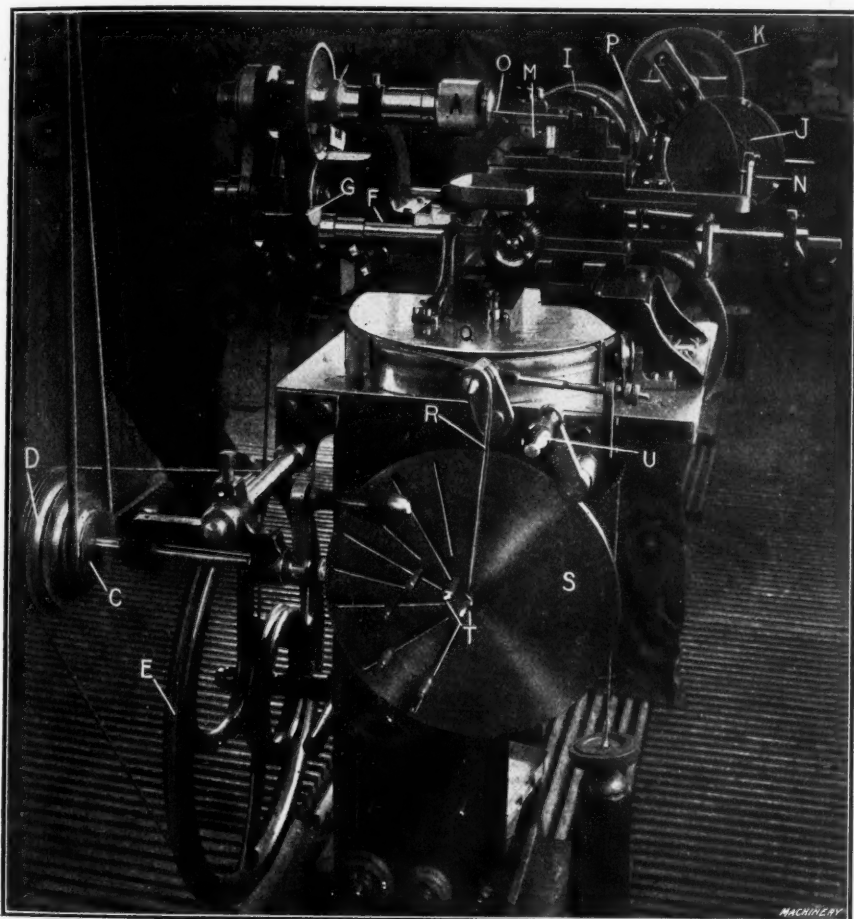

Fig. 11. Swiss "Brocade" Machine, which produces Special Designs of Engine Turning

a pantograph arrangement. From this bar, motion is transmitted through a universal joint and a shaft running parallel with and under the tool-slide M. As tool-slide M is fulcrumed at a point directly under the point of the cutting tool, it is consequently given an up-and-down oscillating movement by means of this shaft and levers connected to it. By changing the position of the ends of the universal joint, the tool O can be put into the work to any desired depth.

The ratio of the gears driving the filling-in pattern, to those operating pattern I, can be changed so as to alter the pattern of the work. Barley-corn filling-in cams P are also provided which have a series of indentations and projections distributed around their peripheries. These cams have slightly different patterns, and any one of them can be brought into operation as desired. The cams are held on a shaft which is driven from the holder carrying plate I, by bevel gears, the rear face of the plate-holder being formed into a bevel gear. Through a steel pointer, not shown, these cams P also give a slight oscillating movement to the tool-holder M carrying the cutting tool O, which produces a neat barley-corn pattern in the

bottom of the depressions, where neither of the other two patterns act.

The work-holder head is mounted on a circular table Q, which is rotated to swing the head to conform to the shape of the back by a wire rope R. This rope is wound partly around the table and is fastened to it by a dog, and is also fastened to dogs T held on the faceplate S. This faceplate is provided with a series of radial slots in which dogs T are located, the latter being adjustable to any position. It is also provided with a spur gear at the rear, and is driven through change gears from the main driving shaft. As the faceplate rotates, it unwinds the wire rope from table Q, and consequently pulls the latter around, which action swings the head carrying the work. The table is graduated and a pointer is provided so that it can always be started from the same point, after it has been swung around by the hand-crank U to insert a new piece of work in the chuck. The unwinding of this wire R imparts a movement to the head which approximates closely an involute curve.

The principle employed in driving the front shaft F for rotating the work is both interesting and novel. From the preceding description, it will be seen that the work-holder must swivel through an arc, and also be rotated at a constant speed irrespective of its position. This is accomplished by double-face miter gears called "A gears." These gears roll on each other and the center of contact is always directly in a vertical line passing through the cutting point of the tool O. If this were not the case the pattern would not be accurately reproduced.

A pantograph arrangement of levers compensates for the size of the case being brocaded, and the position of the dogs T is altered to provide for the changes in the shape of the back. The slide on which the pantograph arrangement of levers, tool-slide M and pattern plates I and J are held is traversed by a worm and worm-wheel from the rear driving shaft. The cutting tool starts at the outside circumference of the case and works in towards the center. The machine is automatically stopped when the work is completed by a bracket held on the slide carrying the pantograph arrangement, which comes in contact with an adjustable stop screw in a lever held under a latch. This bracket pushes the lever from beneath the latch and shifts the belt on the countershaft, thus stopping the machine.

Special Designs and Colored Gold

Many watch cases are furnished with elaborate designs such as plated work of colored gold, and gilded. The gold-plated patterns are cut out in punch presses and soldered onto the back of the watch. The patterns are made in all sorts of color, which is accomplished by alloying coloring matter with the gold when melting. Most of the designs cut on the Swiss brocade machine are gilded in an electric bath, colored gold being used as the annode. The part of the back not to be gilded is coated with shellac, which is removed in hot water after the work has been gilded.

* * *

Some time ago there was exhibited before the French Academy of Science a small dynamo, the total weight of which is claimed to have been only one-fifth ounce. This machine measured about 0.6 inch in height and length. The diameter of the armature was about one-quarter inch, and the magnet was wound with silk-spun wire 0.002 inch in diameter. The total length of the field wire was about five feet. The collectors and brushes were constructed exactly as in large dynamos. When run as a motor, the machine consumes about two amperes at two and a half volts and runs at a very high speed, making a humming noise like a large insect.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

AUGUST, 1912

PAID CIRCULATION FOR JULY, 1912, 24,575 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MECHANICALLY-GUIDED WELDING AND CUTTING MACHINES

The mechanically-actuated oxy-acetylene torch for cutting shapes from iron and steel plates, described in the July number, is one of the most interesting developments in metal working apparatus brought out in the past decade. The oxy-acetylene torch fed with an excess of oxygen becomes a cutting tool of extraordinary efficiency, making a narrow clean "saw" cut of any desired pattern at a speed in thick plates that cannot be equalled by any existing machine tool. Mounted on a pantograph frame, the torch is made to follow a pattern traced on a drawing, and the rate of traverse is fixed by an electrically driven feed wheel. Being capable of cutting steel three inches thick, the apparatus should obviously be of great value in die making.

The use of a gas flame as a cutting tool evidently is capable of still greater development when the torch is guided and traversed mechanically. The flame is used at its highest efficiency, and the shapes produced require a minimum of finish to meet the requirements of many lines of metal-working. The process can be regarded as another of the auxiliary processes of which grinding, drawing, extrusion and swaging are examples, that extend the economical possibilities of metal working, and thus directly promote the usefulness of the so-called "standard" machine tools in those fields for which they are best adapted.

* * *

TOOLMAKING AND EFFICIENCY

In these days of interchangeable manufacturing, when the tool designer and toolmaker are chief factors in determining the kind and quality of accessory equipment provided for manufacturing, and, therefore, to a large extent in determining the efficiency of the production departments, their attitude toward efficiency assumes great importance. The production of fine tools, jigs and fixtures is to some degree an artistic job, requiring men who love the work and exercise their in-

genuity because they love it rather than for the wages paid for the work. To men of this disposition some of the principles of higher efficiency in shop management as applied by enthusiastic organizers are very distasteful. This mental attitude of the expert toolmaker, as expressed in the following paragraph, taken from a recent letter, is important:

"I have been through the mill—made master plates, and all classes of tools for the finest and most accurate instruments.

* * * * * * * * *

Too much is said by most writers regarding speeds, cuts, angles of tools, etc., for their articles to be of value to a toolmaker. A toolmaker is not working on a premium basis, nor is the nature of the work such that a table of speeds could be compiled that would be worth a row of pins, and a table of angles, etc., simply confuses a young toolmaker and especially one who is endeavoring to get the rudiments of toolmaking by study."

While it is undoubtedly true that the data so useful to the machine shop in promoting efficiency have little direct application to the toolroom, we believe that toolmakers generally should have a clear idea of shop conditions and the importance of speeds, feeds, cuts, cutting angles, etc. A toolmaker who has been a machinist and has developed the artistic quality and skill of the toolmaker is likely to be more practical and efficient from the production standpoint than one who has been a toolmaker all his life. Toolmakers should guard themselves from becoming absorbed in their specialty to the exclusion of the practicalities of the shop. Too much concentration on one thing makes for narrowness, and the narrow man is not a desirable development in any walk of life.

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SAFETY APPLIANCES AND THE WORKMAN

Some years ago, when the agitation for safety devices in work-shops began to be carried on in a systematic manner, it was directed mainly towards the manufacturer, exhorting him to install devices to safeguard his workmen, and this agitation has in the last few years produced the desired effect with many large concerns. But as these devices became more numerous it was found that in many instances the problem was not solved, for a second difficulty arose— that of inducing the workmen to make proper use of the safeguards installed. Men who have been accustomed for years to working around dangerous machinery not provided with adequate protective devices, are liable to develop a spirit of bravado and ridicule new devices intended to safeguard them. Instances are recorded where workmen have deliberately removed the safeguards, claiming that they were unhandy and hindered them in their work. In some cases, no doubt, safeguards may have been improperly designed and caused inconvenience to the workmen, but it is probable that in the majority of cases the objections of the workmen have been due to prejudice towards innovations.

In order to counteract this opposition of the workmen towards safety devices, it is necessary that the management should educate them in the proper use of such appliances. A notice such as the following does not reflect credit upon its originator: "Use the accident guards; if any workman does not intend to use these wherever possible, he will please report to the office for his pay." Instead of securing the cooperation of the workman in preventing accidents, such a notice will merely arouse his antagonism. One firm that has been remarkably successful in reducing the number of accidents in its shops has made use of an entirely different method. When new safeguards were placed on the machinery, their men were thoroughly instructed how to work without being inconvenienced by the appliance. They were given an opportunity to complain if they found that the safeguards interfered with their work; and, if practicable, the design was altered to suit the conditions. In this way, the cooperation of the worker was secured, and security against accidents was increased. There is, perhaps, no condition where cooperation between the management and the workmen is more necessary, nor where it results in a better understanding between employer and employes, than when they meet on common ground, in an endeavor to prevent accidents in the shops.

ELIMINATE THE HUMAN FACTOR

On July 4 forty people were killed outright and many injured by a rear-end collision on the Lackawanna Railroad at Gibson near Corning, N. Y., where an express running at full speed crashed through the rear cars of a passenger train. This train was protected by a flagman and by automatic block signals, but these were not seen by the engineer of the express, probably because of a fog which prevailed at the time. The present "'safety" system is reasonably safe, so long as the employes are alert and watchful, but it is not proof against carelessness or negligence. The block signal may be set for danger, but so long as the engineer stands between it and the throttle, there will be wrecks and loss of life. To prevent them, the elimination of the human factor is necessary.

There are various inventions for automatically stopping a locomotive in case of danger, and if none of them are perfect they can probably be made as nearly so as the semaphore, by experiment and use. An expression of public opinion may overcome the indifference of railroad managers to this improvement.

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A NEGLECTED FUNCTION OF ENGINEER-ING SOCIETIES

In another part of this number a brief review of the history and activities of the British Engineering Standards committee is given, from which it appears that the British engineering societies recognize as one of their most important functions, the compilation of data for the standardization of specifications for engineering work, machine details, etc. Very little of this kind of work has been done by the engineering societies in the United States. The American Society of Mechanical Engineers has done very useful service in bringing about the standardization of machine screws; but important as this work has been, it is insignificant when compared with the great need and the unlimited opportunity for the standardization of hundreds of details in the mechanical engineering fields.

The British engineering societies have set a fine example, and by the successful accomplishment of their work have proved that it is possible to formulate certain standards upon which all manufacturers can agree. Our engineering societies are neglecting a great opportunity by not devoting themselves to work of this character. No other body is so well fitted to render this important service as a national engineering society and it should be considered a duty by all of them. The important work of the national engineering bodies can never be done at the conventions, because these are, and probably always will be, largely social functions; but a vast amount of matter of permanent value would be available to the engineering profession if the papers presented at these meetings were crystallized into permanent records by being used as an aid in preparing standards for mechanical practice. In addition, the engineering societies would then become a kind of clearing house for mechanical information, where data relating to standards of all kinds could be readily obtained, and where the reason for the adoption of these standards could be ascertained.

At the present time, there seems to be no one subject to which the engineering societies could devote themselves with greater profit than to the establishment of engineering standards. There is in the mechanical engineering field, at least, a hopeless confusion as to the established practice with relation to many details of machine design and shop practice. No other body is better fitted than the national engineering societies to clear away this confusion.

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At one of the busy machine shops in the heart of the city of Boston where the machinists prefer to take but one-half hour for their luncheon and thus make their day one-half hour shorter, the management allows the men to go to luncheon at 11:45 returning to work at 12:15; thus the men are enabled to get into the luncheon rooms and restaurants just before the rush hour commences, which insures them prompt service and good lunches.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT—2

CAUSES OF INDUSTRIAL INEFFICIENCY

By FORREST E. CARDULLO*

So far this article has considered only the broad aspects of industrial administration. In order to get a better idea of the objects of scientific management, the methods which it is likely to adopt, and the obstacles which it must overcome, I propose to classify and describe some of the causes of inefficiency in our industrial life. In studying the causes of inefficiency we will discover the remedies which a proper system of administration should apply, and develop some of the principles underlying scientific management. I do not claim that all the faults which I will describe are prevalent in every industrial plant not under scientific management. I will admit that most of them can be eliminated without the complete adoption of scientific management. I do know, however, that they are astonishingly prevalent in our industrial life, and that neither conventional nor systematic management has succeeded in uprooting them.

The causes of inefficiency may be divided into three classes: The first are those causes which are chargeable primarily to the employer, the second those which are chargeable primarily to the workmen, and the third those which are chargeable primarily to our political and industrial system.

Those causes of inefficiency which are chargeable primarily to the employer may, in turn, be divided into two classes. Those of the first class arise from a lack of knowledge. They can be remedied by showing the management the possibilities of better methods. Those of the second class arise out of moral defects on the part of the employer, and will require more than a change in the system of management or full information of the conditions of the plant in order to eliminate them.

Mental Laziness

The first and most prolific source of inefficiency is mental laziness. Most of us dislike to think. While a good many of us will devote a spare hour now and then to the consideration of some interesting subject, no man will, if he can avoid it, devote two hours a day, not to mention eight hours a day, to the task of devising and comparing methods of work. That kind of thing is entirely too strenuous to suit the average officer of administration. In the average plant, each officer places upon the shoulders of his underlings the burden of detail for which he himself ought to be responsible. When work is to be done, the manager "puts it up" to the superintendent. The superintendent, in turn, puts it up to the foreman, the foreman to the gang boss, and the gang boss to the workman. Upon the workman devolves the task of devising the methods and of planning the details of the work. Now as I will show later, the workman is no fonder of thinking than the management, and performs his task in that way which involves a minimum of mental effort. He is not to be blamed for so doing, because he has merely followed the example of the management. It is the duty of the management and not of the men to study the work, to discover the most efficient methods, and instruct the men in those methods. When, because of lack of instruction, the men fail to perform their work in the most efficient manner, it is the fault of the management and not of the workmen. Conventional management is fundamentally wrong, in that it compels the workmen to originate the methods, and leaves to the management only the task of criticism.

When the management of an industry is reproached for laziness in not properly directing the workmen, the officers of administration will usually reply to this effect: "These workmen which we hire are supposed to be competent men. They are experts in machine molding, tool dressing, lathe work, or whatever it is that we hire them to do. They have devoted their lives to these lines of work, and know a great deal more about it than we do. When a man receives a job, he can devote his entire attention to that one job. His task is easy, because he has to think of but one thing at a time. If we

devised the methods of work, we would have a thousand jobs to figure on each day. They could not receive the same amount of attention that they get now, nor would that attention be as satisfactory, since we are not experts, and the men are. When you ask us to direct the workmen in the details of their work, you are demanding of us an overwhelming and impossible task."

In answer to this argument, it is only necessary to say: First, while the workmen are usually much more capable than the management, this is due to the lamentable ignorance of the management, and not to the extraordinary knowledge of the workmen. It is practicable for the management to acquire and apply knowledge which it is impossible for the workman to have. Second, many shops that are eminently successful do direct all of the acts of their workmen. Third, when the workmen devise the methods of doing work, they are handicapped by being obliged to use such tools and machines as the management provides, while, when the management devises the methods, they can and will secure the proper tools and machines for doing the work.

Prejudice against So-called Non-productive Labor

A second source of inefficiency is a dislike on the part of most managers to employ a considerable executive staff to direct the efforts of their workmen. The management balks at such a staff, and claims that "non productive" labor is a necessary evil if you have to employ it, and an unnecessary evil if you can do without it. In the old days draftsmen were regarded as an unnecessary evil, and the designing was done by rule of thumb and the head patternmaker. Experience has shown that Johnny Pencilpusher is not an evil, nor is he unnecessary, and that it pays to employ him. Accordingly he is now classed as "productive" and not as "non-productive" labor. The men who direct the work of the shop are just as necessary as the men who make the designs, yet it is difficult to persuade the average manager that a large executive staff is desirable even when you can show him that a gain will result from its employment. The attitude toward such a staff is well shown by the name "non-productive," so often applied to this class of labor. The labor of the planning department is just as truly productive as the labor of the drafting department, the machine department, or the erecting department. A new attitude in regard to the employment of indirect labor is a pre-requisite to greater efficiency in many of our shops.

Timidity of Capital

A third fault of management is timidity. Capital seems to be ruled by fear quite as often as by judgment. Men dislike to risk their money in something which they feel is not absolutely sure to bring adequate returns. They especially dislike to risk money in any investment which is of such a character that they cannot recover the principal in case they decide to give up the enterprise, even though adequate returns are almost certain. Managers often hesitate to spend money for new tools or equipment until other firms have tried the tools or equipment and found them to be successful.

Probably one of the best examples of this is the difficulty which Mr. George Corliss had in selling his engines at a reasonable price, when they were first brought out. It will be remembered that in some cases he had to take for his pay the value of the coal which his engine could save in a given period of time, and was under bonds to take out his engine and reinstall the old one in case the purchaser decided that the new engine was unsatisfactory. Just as Mr. Corliss' customers were fearful of spending money for an improved type of engine, and insisted on making a contract which was, in reality, unfavorable to themselves, so the present-day employer is fearful of assuming the expense incident to proper management, even though it can be shown that great gains ought to be realized from proper administration.

Lack of Foresight

This brings us to a fourth fault of management, which is lack of foresight. The management, in performing the work of today, fails to make allowance for the needs of next week, or the growth of next year. Plants grow in haphazard fashion. Equipment is added without making plans for the future. No attempt is made to insure that there will always be a corps of trained workmen and a staff of able foremen. The lack of definite and far-reaching plans for future work is not felt at the time that such plans should be made, but is felt later.

Mental Inertia and Lack of Adapability

A fifth fault of management is one which may best be described as "mental inertia." Managers tend to follow methods which have been satisfactory in the past, but which changing conditions have made unsatisfactory for present requirements. Whenever a new invention of any importance is introduced into a shop the conditions of work are greatly altered. The introduction of high-speed steel is a case in point. When the time required for machining work is cut down to a third of that formerly required, the amount of crane service for a given number of machines is trebled. The foundry and forge shops must be made very much larger in order to furnish the stock required by the machine shop. The amount of storage room required for stock and for finished product is greatly increased. The relative importance of different items of cost is radically altered, and the nature of the problems of administration are greatly changed. Notwithstanding these changes, we will find that in most cases the management will attempt to get along with the least possible change in equipment, and in methods of work and administration. Many men resist change simply because it is change, in spite of the fact that the change may be desirable.

One of the best examples that comes to mind of the mental inertia that prevents the adoption of new ideas is the general disregard of Mr. Taylor's discovery that the use of a heavy stream of water at the cutting point of a roughing tool, increases the permissible speed of cutting by forty per cent. If the machines of a shop are engaged on roughing work for one-third of the time, by the use of such a stream of water their output will be increased by thirteen per cent. In a shop in which 100 men are employed on machine work, this will mean a reduction in the cost of machining of about $20,000 per year. To install a system for distributing soda water to all the machines in such a shop, and for returning and purifying the water, will certainly not cost more than $20,000, yet, so far as the writer is aware, there is only one shop in which such a system has been installed, even though it would unquestionably pay one hundred per cent on the investment. This is an example of bad management arising from mental inertia, which occurs in almost every shop. When the subject is brought up in any plant, the management fortifies itself in its obstinate attitude, by advancing as arguments statements which are untrue, for instance, that the system costs more than it is worth, that the soda water destroys the machines, or that it is always giving trouble. Were the management to give the matter proper study however, it would find that practical experience has demonstrated that the benefits realized are so great that their shops cannot afford to operate in any other way.

Lack of Study of the Industry

A sixth and probably one of the greatest of all causes of inefficiency is the fact that the management very seldom makes a careful study of the industry. In the few cases where a careful study is made, it is usually done for the purpose of improving the materials used or the quality of the output, or increasing the amount of work turned out by the use of a given method.

It is of equal or even greater importance that the methods themselves should receive the same careful study. Probably the best example of a scientific study of methods of manufacture is the work of Mr. Taylor on the art of cutting metals, to which reference has already been made. It is probable that a similar study of methods would result in equally important developments in other lines of industry. Such studies are not made for three reasons. In the first place, managers do not realize the need of such studies nor the advances which are possible. In the second place, very few men are capable of making such studies. In the third place, inertia opposes the changes which would result from such studies, and timidity hesitates to expend the money necessary to carry them out. Very few managers would have the courage to commence an investigation whose final cost would be $800,000 and which would take twenty-six years for its completion, and while the management of some very large industries might be willing to

take a chance on an investigation of this kind, even the most sanguine would deride the possibility of such an investigation producing such valuable and far-reaching results as have followed from Mr. Taylor's experiments. When all is said and done, it will be found that most managers want someone else to do the experimenting, feeling that by so doing they can participate in the profits of such work without sharing its expenses.

Systems of Rewarding Labor

A seventh source of inefficiency in many industrial plants is the system of wage payment adopted. It would be hard to devise wage systems better calculated to limit efficiency than the two which are in most common use; namely, the day wage plan, and the piece-work plan with frequent cuts. Under the day work plan, the man receives no reward for his efficiency, he is instead punished for inefficiency. This is a method which is fundamentally wrong, and only to be employed when no other method is possible. When a man receives day wages, he is paid for the time which he spends at his work. The first question which arises in connection with this system of wage payment is: What wages ought a man to get? The answer is he ought to get all he can. He is selling a commodity, labor. He asks for it the highest price he can get, and is justified in so doing. His labor is measured by time and the value of the labor performed in a given time has nothing to do with the payment which he receives. The only thing which limits him is the fact that if he does not do a satisfactory amount of work, he will be discharged. What constitutes a satisfactory amount of work, neither he nor anybody else knows. The whole thing works out very much as it would if a man when buying a quart of milk, were to insist simply that there be some milk in the quart measure, and the matter of how much milk there was to be in the measure, should be left with the milk-man, with the understanding that the milk-man would lose his customer in case the amount of milk was not satisfactory to the purchaser.

When you discuss with the average workman the question of proper wages and the proper amount of work to be done in a day, he will tell you that his motto is "a fair day's work for a fair day's pay." Different men, however, have very different ideas as to the amount of work which constitutes a fair day's work. Some employers think that it is all the workmen can possibly accomplish. Some workmen think it is the least that they can accomplish and still not get fired. Most workmen think it is work they can do when working steadily at the gait that habit and temperament have fixed in their cases. Most employers think it is the amount of work which their most honest and industrious employe normally does. When there is such a great diversity of opinion as to what constitutes a fair day's work, it will naturally be seen that there will be great diversities in the efficiencies of different men and different shops.

When a piece-work plan is adopted, the management usually knows very little about the possibilities of the work. If the management fixes what the men think to be a reasonable piece-rate, the men will soon so increase their output that they will be making exorbitant wages. The management will then cut the piece-rate, and after the men have experienced a series of cuts as a result of successive increases in efficiency, they will discover that the management does not propose to pay them more than a certain amount of money, and will work just hard enough to secure a trifle less than the maximum amount they can secure without experiencing a cut.

If, on the other hand, a proper piece-rate is established in the first place (i. e., one by which the men can earn fifty per cent to one hundred per cent more than a regular day's wages when they have reached their best efficiency), the men will believe that it is impossible to earn reasonable wages under the proposed piece-rate, and will decline to accept it.

"Holier than Thou" Spirit of Some Employers

An eighth cause of inefficiency is one which is happily becoming less frequent. It is a disposition on the part of some employers to regard their workmen as being of a lower order of humanity than themselves. I have talked with such men on more than one occasion. Among their associates they were highly regarded for their kindness of heart, but I have heard them speak of their workmen as "beasts" and "ignorant brutes." No man who regards his employes in that light can be persuaded to adopt scientific management nor can he bring the efficiency of his plant to a high standard, because such feelings will unconsciously affect his attitude in dealing with his employes, arouse their antagonism, and destroy that feeling of cooperation which is the essential basis of high efficiency.

On the other hand, even though the employes of such a man are ready and anxious to cooperate with him, his attitude will prevent him from doing many things which would utilize such potential cooperation to advantage.

Avarice of the Management

The last source of inefficiency of which I will speak is avarice on the part of the management. Avarice reduces wages, cuts piece-rates, purchases inferior materials and equipment, employs unskilled labor, skimps on supplies and makes unjust exactions of its employes. Avarice refuses to expend money for the collection of information, for increasing the facilities of work, and for improving the efficiency of administration. Avarice hampers the administrative staff at every point. Avarice is the sin of the board of directors and the stockholders, and not of the superintendent and his staff. Scientific management often requires a large staff of clerks and costly experiments when it is being introduced into a new line of work, and this effectually prevents its adoption by the avaricious employer.

Not only will avarice prevent the adoption of scientific management in a great many cases, but it is also very likely to give scientific management a black eye by adopting some of its methods, without adopting its spirit. An avaricious employer finds himself coming out second best in competition with one who utilizes scientific management. He attempts to appropriate the experience of his competitor in the same spirit in which he imitates his trademarks, copies his designs, and steals his methods of work. Now while it is possible to imitate a trademark or steal a method, it is not possible to imitate or to steal the scientific habit of mind or the spirit of fair play, which lie at the basis of scientific management. The reward and instruction are just as essential to scientific management as the discovery of a method of work, but the avaricious employer cannot be made to see this. When his neighbor has discovered a method of work better than that which his workmen employ, he will attempt to force his workmen to accomplish the same results without teaching them the new method and without offering them the reward to which they should be entitled, and his attempts will therefore always end in failure. While there is no question but that scientific management will continually discover new and improved methods, processes and materials, and while these improvements will gradually find their way into shops which do not employ scientific management, the extraordinary performances possible under scientific management will never be achieved in the shops of the avaricious employer because knowledge alone will not lead workmen to increase their efficiency.

I have not by any means exhausted the list of causes for inefficiency which arise from faults of the management. It would be as easy to name a hundred as to name nine, but the task is not agreeable. I have endeavored merely to point out the fact that such faults exist, that they can be remedied, and that before scientific management can be applied to an industry, they must be remedied.

Causes of Industrial Inefficiency due to the Workmen

While most of the causes which lead to inefficiency are chargeable to bad management, I would not have it inferred that the workmen are free from blame in the matter. I know of many shops in which the blame rests almost wholly on the workmen. In one that I have particularly in mind, the management is keenly alive to the possibilities of improvement. They could today increase their output fifty per cent, and would gladly increase their wages in the same proportion, if the workmen would cooperate with them. Time and again they have attempted to make changes leading to higher efficiency, but in every case the opposition of the workmen was so strenuous that they were convinced that it was the part of wisdom to accept the inevitable and to permit the inefficiency which they deplored. Were they to insist on a change of

methods, it is quite likely that labor troubles would force their plant into bankruptcy on account of their limited capital.

The Natural Pace of Workmen

The first source of inefficiency chargeable to the workmen is their disinclination to work at any other than their natural pace. If a man is allowed to work as he pleases he will soon settle down into a certain pace which suits his temperament and nervous organization, and will keep to that pace without very much variation from day to day. I may call this his natural pace. It is perfectly possible for such a man to work very much faster without tiring himself, and if he is properly trained and given adequate inducement, he will adopt the faster pace, and make it his habit to work at that faster rate. I may call this faster pace his proper pace. In order to illustrate the relation of the natural to the proper pace, I would like to compare them to the natural gait which a horse takes when his driver allows him to go at his own free will, and the proper gait which an experienced driver will set for the horse, in order that he may accomplish the best results. A careful and experienced driver will get a great deal more work out of a horse if he urges him to travel at the proper gait. Notwithstanding this, the horse will be no more tired at the end of the day when driven at the proper gait, than he would be had he traveled at his natural gait. The faster gait does not mean undue wear and tear, and the horse will maintain good health and vigor just as long when working for a careful driver who makes him work, as he will if he works for an indifferent driver who allows him to do as he pleases.

A man differs from a horse in two ways. In the first place he cannot be driven, and in the second place, a reward offered him for extra labor must seem to him to be reasonable. It is not difficult to get a man to change his pace if you offer him an adequate reward. If, however, he finds that the reward is not always forthcoming, i e., if he finds a piece-rate being cut or a premium reduced, or if he feels that the reward is inadequate, he will not respond. He cannot be driven by threats of discharge or by fines, and he cannot be coaxed by broken promises or gold bricks.

Lack of Ambition

A second source of inefficiency is lack of ambition. While most men will be stimulated by a proper reward, there are some classes of labor which cannot be reached in this way. Some workmen do not accomplish as much or as good work when well paid as they do when poorly paid. In certain sections of the South contractors find that when negro laborers are paid seventy-five cents a day they will work a full week, when paid $1 a day they will lay off one day in the week, and when paid $1.50 a day they will lay off half the time. The reason is that these men are not ambitious. Four dollars and a half a week supplies their needs, and when they have earned that amount they do not care to work any more. It is needless to remark, however, that the average artisan is not of that character. He is ambitious, and invariably responds to a suitable reward, unless he believes that in so doing he is acting against the best interests of himself or his fellow workmen.

Mental Laziness of Workmen

A third source of inefficiency lies in the fact that the workman does not like to think any more than the superintendent, the foreman, the manager, or the board of directors. He prefers to work without thinking when it is possible. Few men are physically lazy, but nearly all men are mentally lazy. The only way that a man can work without thinking is to do the job the way in which he or someone else has done it before. When he has to do a new job, he must do some thinking, but usually it will be found that the workman will adopt the method which requires on his part the least mental effort for its origination. Very seldom is the method adopted the best one. In the course of his work, ideas will come to the workman. Sometimes these ideas are good. If the ideas make it easier for him to perform the work, that is, if the new method is in accord with his temperament and habits, the idea is put into practice. If the idea makes it harder for him to work, that is, if it requires him to do something disagreeable or not in accord with his habit, the idea will

be rejected. An investigation of methods of work will usually show that men who are physically restless will often adopt difficult and tiresome methods of work on account of their temperament. Men who are physically lazy will adopt easy-going and slipshod methods of doing work. In every case the workman seeks to conform the method to his temperament, in order that the mental and nervous effort which he must make in accomplishing the work shall be a minimum.

Fallacy of the Arguments against a Good Day's Work

A fourth, and possibly the most prolific source of inefficiency is the belief held by many workmen, and unfortunately, taught by many union officials, that in doing efficient work men are displacing other workmen and lowering wages. There can be no greater economic fallacy than this. One illustration alone will serve to make clear the falsity of the argument that a man who works efficiently reduces wages and the opportunities for labor. Let us suppose that on account of the increased efficiency of the workmen, the cost of making cement is materially reduced, and the output greatly increased. Of course, if the demand for cement were fixed at so many barrels per year, some cement makers would be thrown out of employment, but with the increased output and diminished cost there will come an increased demand for cement, and there will be a greater amount of concrete construction. Instead of reducing the number of men employed, it is quite possible that a larger number of men will be employed in manufacturing cement, and it is certain that a very much larger number of men will be employed in concrete work. If these concrete workers, in turn, become more efficient, cheapening the cost of concrete construction, the use of concrete will be stimulated, more cement makers will be employed, new factories, warehouses and bridges will arise, and finally every branch of industry will be stimulated by the improvement. The workman who increases his output is a benefactor, not alone to his employer, but to every man in the community. His increased efficiency will result in higher wages, and more general prosperity.

The facts in the case are so simple and so easily understood that it is strange to me that every workman does not understand and appreciate them. If all workmen were twice as efficient, the annual value of the products of labor would be twice as great as at present. The products of labor are distributed among the community (somewhat inequitably it is true), and the share which each member of the community can get will be proportional to the total amount to be distributed. Any increase in efficiency means that there will be more goods to be divided, that every one will get a larger share, and that the community will be benefited. It is impossible in an article of this character to go into the subject of economics, but the more the subject is studied, the more clearly the advantages of increased efficiency will be seen. As a matter of fact we can only reach that millenium when poverty, disease and unhappiness will disappear, by the straight and narrow path of increased industrial efficiency, and anything which impedes that efficiency is in reality as great a crime against humanity as the poisoning of a well, or the adulteration of drugs.

Enmity to Employers

A fifth source of inefficiency chargeable to workmen is a feeling of enmity against their employers. A great many workmen are unable to see the community of interest between the workman and the employer. Some workmen act as if they believed that the two were at war, and that anything done to injure the employer was a benefit to labor.

Now there will always be discussion and bickering between capital and labor as to how the wealth created by their joint effort should be divided. There can, however, be no discussion over the point that each must have a share, and that the amount of wealth which they can divide between them, and the size of the share to which each is entitled, will be great or small according as they are more or less efficient.

Any sensible man can see that the more efficient the workmen are, the more prosperous their employer will be, the better able he will be to extend his works and employ more labor, and the higher wages he will be able to pay. Until all feeling of enmity between capital and labor is replaced

by a knowledge of mutual need and appreciation of mutual interest, and a desire for mutual success, not only efficiency, but also prosperity, must suffer.

Causes due to Political and Industrial Systems

Those sources of inefficiency which arise out of the imperfections of our political and industrial system are just as important as are those due to faults of management or of workmen. Unlike the latter, however, it is impossible for either the management or the workmen to correct the faults we are about to consider. It is not usual to discuss such matters in a technical paper and on that account this phase of industrial administration will be dealt with in the briefest possible manner, confining the discussion to a description of the causes, and not to a discussion of legal remedies. Everyone studying the industrial history of this country will be struck with the fact that we have alternate periods of feverish activity and of deadly dullness. In so-called "boom times" factories are run twenty-four hours a day, efficiency and quality of workmanship are sacrificed to output, our railroads are crowded to the limits of their capacity, untrained and inefficient men find ready employment in all trades, ill-considered plans for industrial expansion are hastily carried into effect, inferior and unsatisfactory equipment is eagerly purchased and installed because no other kind is available, and the general efficiency of our industrial system suffers a severe decline.

As a result of this inefficiency a "period of business depression" sets in, men are discharged, plants lie idle, wages fall, men are forced to move at great expense, and to seek new employment for which they are not trained, and again inefficiency is the order of the day. Now there is no reason why these alternations of activity and dullness should occur, except that our methods of conducting business are wrong. Proper laws, proper methods of banking, improved business customs, and a rational development of our natural resources and methods of communication will very nearly eliminate such conditions.

Certain industries, however, are subject to seasonal variations of opportunities for work. Agriculture and the canning industries are examples. Other industries are subject to seasonal variations in the demand for their products. The automobile industry and the manufacture of Christmas goods are examples. Where the supply of raw materials for an industry is subject to seasonal variations, nothing can be done except that such an industry may be operated in connection with another industry so that the workers and possibly a portion of the plant may be efficiently employed, practically all the time. Where the demand for the products of an industry is subject to seasonal variations, the industry may run steadily throughout the year if an accumulation of stock is permitted. The amount of capital tied up in the stock will usually, in such a case, be less than the capital otherwise tied up in the plant, since a plant which turns out a given product in three months will have to be four times as large as one which turns out the same product in a year, working the same number of hours per day. There is also the possibility of operating such an industry in connection with another industry, possibly of a like character, in such a way that both the plant and the workmen may be efficiently employed throughout the year.

We must all recognize that one of the causes of inefficiency at the present time is the struggle which is going on in the business and political world over the question of whether capital shall be used for the benefit of those who nominally own it, or whether it shall be used for the benefit of the community. Originally the position sanctioned by law was that capital belonged absolutely to the one owning it, and that he might use this capital in any way that he saw fit, except that he might not employ it in levying war on the sovereign, or in committing a criminal act. We are gradually coming to the view that capital must be used for the benefit of the community, and while we believe that the nominal ownership and the detailed administration of industrial enterprise should be left to individuals, we are coming to insist that a business shall be conducted efficiently, that in case the business is not regulated by competition the profits shall be reasonable, and that the methods of making and marketing the products shall be those which will further the well-being and efficiency of the community as a whole, rather than the profits and self-satisfaction of the owner of the business. While we are engaged in this process of changing the fundamental principles of law and of business, we must expect that inefficiency will be more or less the order of the day.

One of the economic sins of the present day which is very effective in destroying efficiency, is foolish and wasteful competition. The construction of parallel and competing lines of railway when one line is adequate to serve the traffic is a case in point. The installation of two telephone companies in the same city, of competing street car and electric railway lines, the duplication of generation and distribution plants by two electric power companies, and competition in other so-called "natural monopolies" are other examples. There are certain kinds of industrial work in which competition is undesirable and inevitably leads to inefficiency, and laws which permit or encourage such competition place a premium upon such inefficiency.

Another cause of inefficiency is frequent and sudden changes in laws, customs, fashions, and social conditions. For instance, a bounty, subsidy, or extraordinarily high tariff may cause the factories and workmen of an industry to be transferred from Europe to America. This transfer means a considerable temporary loss, and in case American conditions are not naturally favorable to the development of the industry, it causes a permanent loss. A few years later the abolition of the tariff or the bounty may cause the plant to be re-transferred to Europe and the workmen to be thrown out of employment, with a further loss. Similarly, a change in the direction or amount of traffic in a given district, the development of new resources, the sudden growth or decline of a transient industry and many similar things may affect the efficiency of a given plant, or even a whole industry. Often these changes are entirely beyond human control, or are incident to increased efficiencies in other and more important lines.

* * *

SHERMAN LAW HELD TO APPLY TO RESTRAINT OF TRADE BY PATENTS

The Supreme Court of Massachusetts, in an opinion of the full bench handed down July 3, advanced the application of the Sherman law to embrace combinations in restraint of trade by reason of patent rights held by corporations. In a suit of the United Shoe Machinery Co. against Euclid I. Chappelle, an inventor who worked for the corporation for $12 a week, the corporation endeavored to force Chappelle to transfer certain patent rights under a contract of employment. Chappelle offered to show that the company was a monopoly and doing business in restraint of trade and contrary to the provisions of the Sherman act, but Judge Hardy refused to admit the testimony. Counsel for Cnappelle took exceptions to his rulings and appealed to the Supreme Court. The decision holds that the lower court erred in not admitting such evidence. Chief Justice Rugg, who wrote the opinion, finds that the question of whether the United Shoe Machinery Co. is an illegal combination in restraint of trade and had monopolized trade and commerce between the several States must be governed ultimately by the Supreme Court of the United States. The opinion states, however, "that no word or phrase in the Sherman anti-trust act reveals an intent to exempt the owners of patents from its sweeping provisions against monopolistic combination."

"We are unable to perceive," stated the court, "any underlying reason for supposing that by implication growing out of economic or business conditions such an exemption was intended. There appears to be no inherent natural distinction between owners of patents and owners of oil which would justify the application of the statute to one and not to the other. The conclusion seems to follow that the comprehensive condemnation of the act against every person who monopolizes interstate commerce by combination with others includes holders of patents as well as others."

* * *

Most men need to ream out their mental cavities occasionally to enlarge their calibre.

CHARTS FOR HORSEPOWER TRANSMITTED BY GEARING AND BELTING*†

By CHARLES E. EVANS‡

The accompanying illustration and the Data Sheet Supplement show a number of charts which the writer has found convenient and useful. Two of the charts in the Data Sheet Supplement give the horsepower transmitted by spur gearing, one of them being used for circular-pitch gears and the other for diametral-pitch gears. When using these charts one can choose the fiber stress most suitable for the material and work in question. The charts do not give values directly proportional to the pitch line speed, but values that are relatively lower for high speeds as compared with low speeds. The light upper dotted line in the charts shows the form the upper

pinion can be used for gears of any number of teeth, thus reading straight across the chart at the right-hand side. The horsepower transmitted by gears of different width of face from that specified can be obtained by proportion.

The following examples are traced in dotted lines on Charts I and II in the Data Sheet Supplement:

A 12-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 2.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 4.1 horsepower with a fiber stress of 4000 pounds per square inch.

A 12-tooth pinion of 1½-inch circular pitch and 4-inch face,
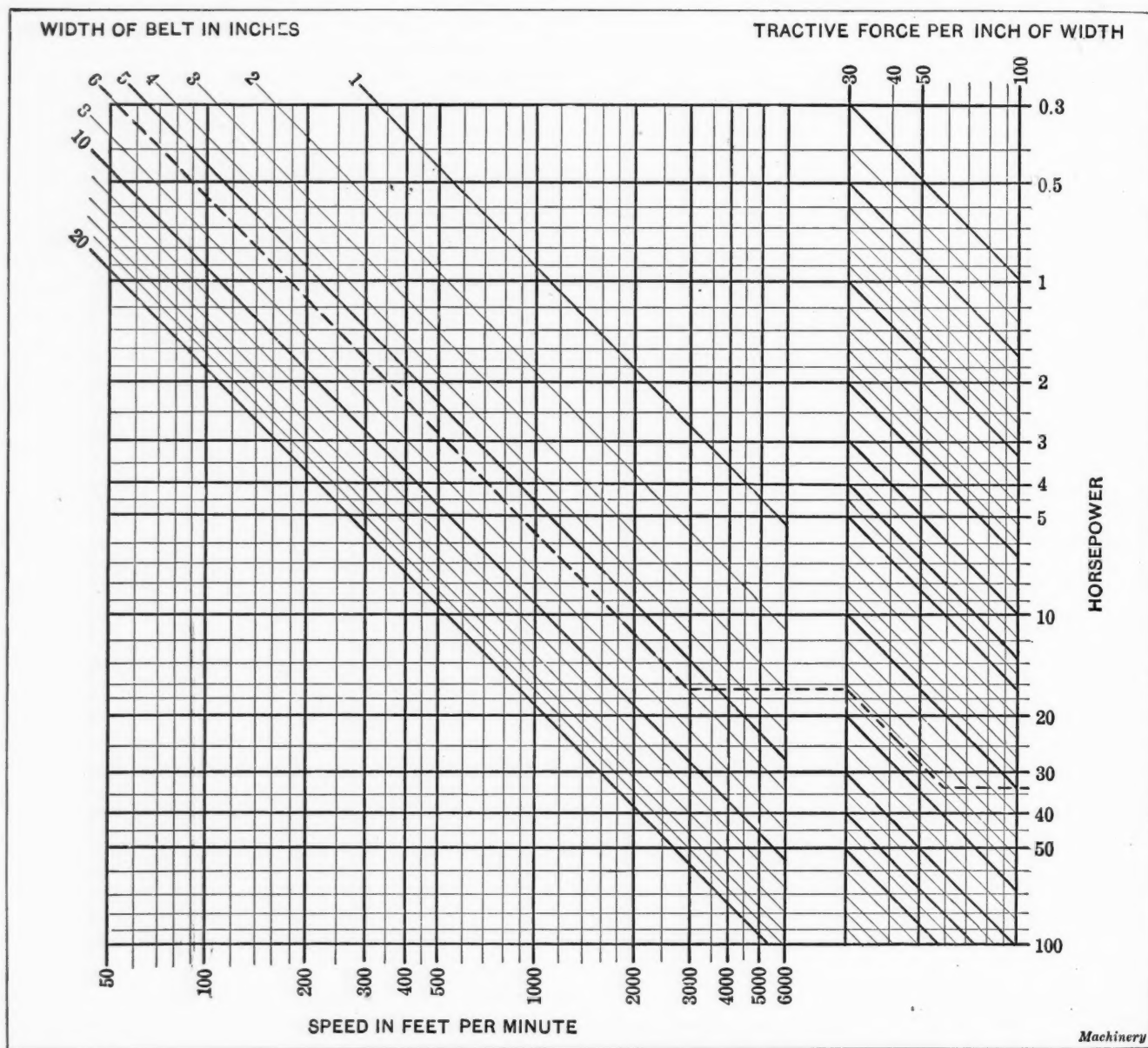
Chart for Finding the Horsepower transmitted by Belting

curve would take if the horsepower were taken as directly proportional to the pitch line speed.

Gears having a large number of teeth have a stronger tooth form than gears with a small number of teeth, and provision has been made in these charts to cover this point, but if it is not desired to determine the results with such refinement as this arrangement makes possible, the values for a 12-tooth

*With Data Sheet Supplement.
†For additional information on this and kindred subjects previously published in MACHINERY, see "A New Gear Chart," December, 1911, engineering edition; "Horsepower Transmitted by Leather Belts per Inch of Width," September, 1906; "Horsepower Transmitted by Belts," July, 1906, engineering edition. See also MACHINERY's Data Sheet Book No. 5, "Spur Gearing," pages 21 to 23, and 26 to 29; Data Sheet Book No. 19, "Belt. Rope and Chain Drive," pages 14 to 16; Reference Book No. 15, "Spur Gearing," Chapter IV, "Strength and Durability of Spur Gears"; and Reference Book No. 52, "Advanced Shop Arithmetic for the Machinist," Chapter VI, "Horsepower of Belting."
‡Address: Fifth Ave., near Ohio St., Aurora, Ill.

running at a pitch line speed of 100 feet per minute, will transmit 3.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 5.8 horsepower with a fiber stress of 4000 pounds per square inch.

The chart contained in the accompanying engraving gives the horsepower transmitted by belts or friction gears. When using this chart one can choose a tractive force per inch of width consistent with the problem in question. An example traced on the chart in dotted lines indicates that a 6-inch belt running at a speed of 3000 feet per minute will transmit 33 horsepower at a stress of 60 pounds per inch of width of belt.

Charts III and IV in the accompanying Data Sheet Supplement are auxiliary diagrams for finding the pitch line or rim speed in feet per minute. Chart III gives this when the diameter and the revolutions per minute are known. The example traced on the chart in dotted lines indicates that a gear or pulley having a diameter of 3.4 inches and running at 500 revolutions per minute has a pitch line or circumferential speed of 445 feet per minute; or if the diameter is 34 inches and the speed 50 R. P. M., the pitch line speed is 445 feet per minute; in other words, the chart can be used for other dimensions than those actually given if proper care is taken with regard to the position of the decimal point.

Chart IV gives the pitch line speed of a gear when the pitch, the number of teeth and the number of revolutions per minute are known. The example traced on the chart by dotted lines indicates that a 13-tooth pinion of 3-inch circular pitch, running at 100 R. P. M., has a pitch line speed of 325 feet per minute.

* * *

HINTS TO EXPORTERS

By ERNST VOEGELI*

From time to time American journals have published instructions relating to the proper crating of machines for export. This is a very important subject, but there are some other points almost as important which are frequently overlooked. Details, which at first sight may seem to be of little or no importance, sometimes cause considerable trouble and damage. With the present-day competition between different firms and different industrial nations, every reasonable precaution should be observed in order to avoid inconvenience to the customer.

A very important point is that machines should be carefully greased before shipping. Solid crating will prevent breakage, and careful greasing will prevent rusting. The machines are often exposed for several days to the mist or fog at the harbors, and sometimes sea water may come into direct contact with them. The boxes may lie for some time in the open air, not even protected against rain. Hence, if not carefully greased, the machines will rust, and it is extremely unpleasant for the customer to receive high-priced and high-class machines in this condition. When badly rusted, the polishing and cleaning almost always injures the accuracy of the machines to some extent, and this may be detrimental to the reputation of the manufacturer of the machine. It is a fact that a good many machines arrive in Italy badly rusted.

Another important point is to have the boxes distinctly marked. Having almost daily had to do with the forwarding of American, German and English machines, the writer has observed that many American firms make mistakes in this direction. They place the address of their customer in large black letters on the box or crate. However, the customer is not always also the receiver. The customers of American manufacturers, on the other hand, are mostly agents and dealers, but the machines ordered by them are sometimes sold in advance and are to be shipped direct to the user's factory. Thus only a small part of the machines ordered are delivered to the address printed on the box, the larger part being forwarded to the ultimate buyer by the customer's forwarding agent. In that case, the addresses on the box are useless.

Difficulties are met with especially when different machines are arriving at the same time for the same machine dealer. Of these machines some are already sold and are to be forwarded direct to the buyers' addresses. The machines may originally have been shipped by different manufacturers in America, but they are all delivered to the forwarding agent at an American harbor, generally in New York City or Boston, and this forwarding agent sends all the machines at approximately the same time to the European forwarding agent. This agent, therefore, only knows that the American agent has shipped a number of machines, but he does not know who are the original shippers. The machine tool dealer gives the European forwarding agent instructions to ship some machines

*Address: Via Morgagni, 28, Milan, Italy.

to one firm, others to another firm, and, perhaps, a third lot to still another destination, while a small part of them will be delivered to his own address.

How, now, is the forwarding agent to distinguish the different machines? There is no way to do it if all the crates are sent to one address. It is not possible to risk having the forwarding agent open the cases and distribute the machines according to the machine tool dealers' descriptions. Some machines might seem very much alike to one not familiar with them, and mistakes would easily be made. The writer knows from his own experience that such mistakes have occurred, simply for the reason that the box bore nothing but the address of the machine tool agent. In one case, where two machines were thus substituted for each other, the agent had to pay a penalty for delay in delivery, as well as the additional freight charges, to straighten matters out. In another case, the delay very nearly caused the customer to refuse the machine and to buy another from an agent who had it in stock for immediate delivery, but this latter machine was made by a competing firm in another country.

In order to avoid such inconveniences, it is suggested that the crates be marked in some way to avoid mistakes. This method is already followed by some of the American firms

					Weight in Pounds		Dimensions
Mark	Number	Packing	Order No.	Contents	Net	Gross	
I.M.T.C.	8531	box	8531	23" Upright Drill			
"	8735	box	8735	16" Engine Lathe with gear box 8' length of bed			
"	8735a	crate	"	Countershaft for 16 x 8' Engine Lathe			
"	9513	box	9513	15" Crank Shaper			

List sent by Manufacturer to Agent for Identifying Shipment

familiar with the export business, and is generally followed by German and other European firms. In place of the machine tool agent's address, it would be advisable to print on the box some distinctive marks and numbers, preferably the initials of the firm which ships the machine and the number of the order. If, however, the order comprises more than one machine, each crate should have a separate number so that every crate bears a distinctive mark. The Jones & Smith Mfg. Co., for example, may use the marks J. S. M. C. with a number. The probability that two or more boxes would bear the same identification marks is very small. These marks and numbers are to be repeated in the invoices, possibly together with the net and gross weights and the dimensions of every crate. This will allow the machine tool agent to give precise instructions to the forwarding agent for the delivery of the machines, and mistakes will be avoided. The writer would recommend a shipping list to be sent to the machine tool agent together with the invoices as soon as the machines are shipped, this shipping list being made up about as shown in the accompanying illustration. Of course this illustration only shows an example, and special conditions may require modifications; but the principle is illustrated.

Another thing worth mentioning is that very small packages containing small tools, catalogues or circulars are frequently sent by express to European countries. This is a slow and expensive way and should be avoided whenever possible. It is preferable to make, if necessary, a number of parcels and to send them by parcels post, or, in the case of catalogues and circulars, as printed matter. It will cost much less and the packages will arrive much earlier.

OXY-ACETYLENE WELDING OF TANKS AND RETORTS*†

By J. F. SPRINGER‡

One of the most important applications of the oxy-acetylene welding process is in connection with the manufacture of tanks and cylinders from sheet metal. In this field the new process promises to supersede soldering and riveting to a very large extent. The advantage over soldering consists principally in the increased strength of the joint and the equality of the expansion and contraction of the metal in the seam and in the work. There is also much less likelihood of the occurrence of poisonous corrosions.

In constructing vessels of sheet metal which are subjected to alternations of high and low internal pressures, it is generally advisable to use special forms of joints at the corners or to avoid corner joints entirely. The stresses on the corner joints become very severe if the corners are of right-angled shape. If the corner is rounded, the effect of the internal pressure at the joint is reduced. In Fig. 1, for example, if the welded joint is made at the square corner AB, it will be located at the point where the stresses on it, acting as indicated by the arrows, will be most severe. By forming the joint in the various ways shown in Fig. 2, the weld will be
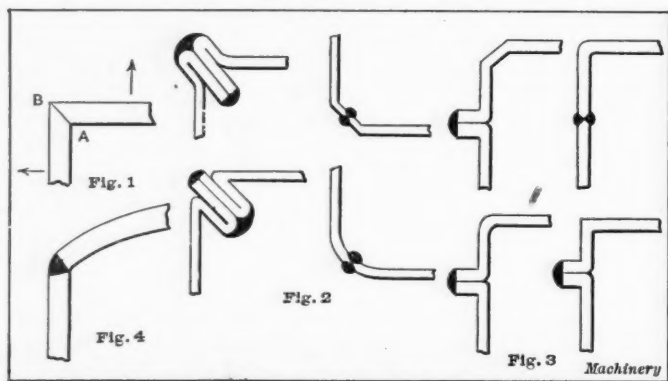
Figs. 1 to 4. Illustrations showing Various Methods of Making Welded Joints

considerably strengthened as compared with a weld that merely joins the two sides at the corner AB in Fig. 1. It is still better, however, to remove the joint from the corner altogether. In Fig. 3 are shown the methods used for doing this. The best method of all to relieve the welds of the excessive
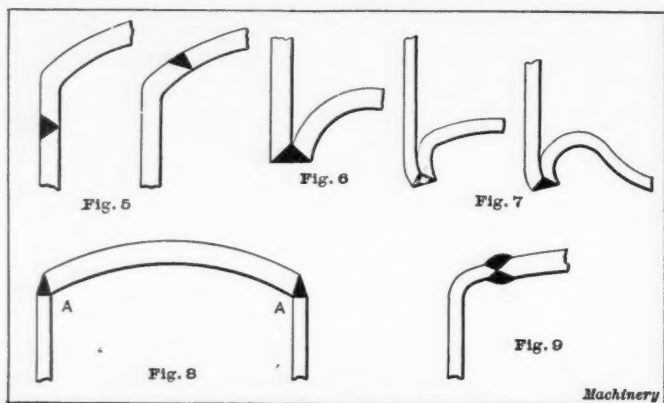
Figs. 5 to 9. Methods of Welding Tops and Bottoms to Cylindrical Shells

corner stresses is, of course, to change the horizontal section to that of a circle.

Tops and Bottoms of Sheet-metal Vessels

One of the most difficult operations in the welding of tanks and retorts is the attaching of the tops and bottoms to cylindrical vessels. One of the first methods employed was that of making a joint as shown in Fig. 4. The welding was done from the outside and could be well finished. However, when the vessel was subjected to pressures from within, a combination of compressive and tensional stresses was produced at

the weld, thus causing cracks. To overcome this difficulty, joints as indicated in Fig. 5, were made. Where the metal is quite thin, sufficient contact of the surface can be secured by bending the metal outward to form a kind of a flange. By using more welding material than necessary to produce a joint flush with the adjoining surfaces, a stronger weld can also be made.

In all these cases, the top or bottom is assumed to be convex on the exterior. Another method, shown in Fig. 6, is to make it concave on the outside. Such forms are especially suitable for bottoms. In Fig. 6 the rim of the bottom is bent and the edges of the bottom and of the cylinder are both beveled to provide a welding groove. Another method which does not necessarily include concaving is to bend up the rim of the bottom for a short distance, the dimensions of the piece being such that this rim snugly envelops the cylinder; the two may then be welded together.

The use of flat tops and bottoms should, of course, be avoided. The

Fig. 10. Example of Tank welded by the Oxy-acetylene Process

expansion and contraction of these during welding are different from those of the cylinder. The flat piece does not yield to the cylinder, and, hence, the work is likely to be distorted. The convexing and concaving of the tops and bottoms provides a suitable margin for yield. Two forms of bottoms are shown in Fig. 7, in both of which elasticity in the diameter is provided for. The bending in of the edges enables the cylinder wall to support the bottom when the latter is under pressure from within. In some cases it may be necessary to prevent diametral expansion of the cylinder when welding. A heavy removable band of metal in the form of a hoop may be used for this purpose. It is placed close up to the location of the seam. Most of the heat from the cylinder will then be absorbed and dissipated by this hoop.

An interesting example of the application of the foregoing principles is afforded by a large containing vessel constructed by Munk & Schmitz, Cologne-Bayenthal, Germany. This vessel is a cylindrical shell, closed at top and bottom, and is formed of sheets 0.40 inch thick in the cylindrical portion and 0.83 inch thick in the end portions. The vessel is 15 feet high and over 9 feet in diameter. All joints were made by the oxy-acetylene torch and the vessel successfully withstood, when tested, a pressure of 90 pounds per square inch.

General Considerations in Welding Tops and Bottoms to Cylindrical Vessels

If the joining of the top to the cylindrical shell were made at the precise point where geometrically the side of the wall joins the top, as shown in Fig. 8, an outward pressure exerted from within and tending to produce a spherical shaped bottom, would tend to make the angles at A more obtuse and would thus produce a tensional stress on the inner portion and a compressive stress on the outer portion of the weld. Hence, it should be carefully noted that this method of joining ends to cylindrical shells is objectionable, and that the methods shown in Fig. 5 should, in general, be adopted.

It is also very important in forming welds of the type described not to forget the effects of expansion and contraction. It is recommended that the weld be hammered during the cooling-off process. The hammering should be discontinued while the metal is still quite hot, and should not be continued below the point where a horse-shoe magnet attracts the iron; in fact, at this point, one has perhaps gone a little too far. Subsequent to the cooling, the region that has been exposed to the high temperature should also be well annealed. This
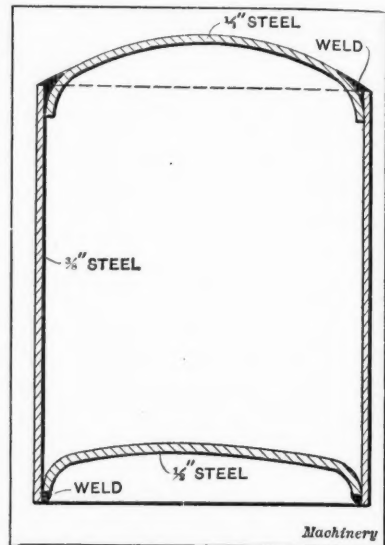
may be done by using two oil torches for gradual re-heating, one from the inside and one from the outside. Incidentally it might be mentioned that in performing the welding operation it is also often advisable to use two welding torches, in which case a weld of the double-V character, as shown in Fig. 9, will be produced. The bottom of such a vessel should be so arranged that the weld is not located where the weight of the vessel itself comes upon it.

As an interesting practical example, the illustrations Figs. 11, 12 and 13 are shown, indicating the progressive steps in welding a cylindrical shell, as well as the welding of a top and bottom to it. A diagrammatical view of a section of the welded container is shown in Fig. 10, the work being done by the Vilter Mfg. Co., Milwaukee, Wis. It will be seen that the top is convex and the bottom concave, as viewed from the outside. The shell is of ⅜-inch boiler iron; the metal in the heads is ½ inch thick. The tank is 20 inches in diameter and 24 inches long. Both heads fit the inside of the shell as indicated.

After welding, this tank was tested at a pressure of 1200 pounds per square inch. For carrying out the test, a hole was drilled on one side of the shell and a nipple inserted after tapping. The tank was then connected with a hydraulic press pump. At 1100 pounds pressure the nipple started to leak, but there was no leak at the welded joints. A No. 7 Davis-Bournonville tip was employed in making the straight weld in the shell, and a No. 8 tip was used for the ends. The straight weld was made in 45 minutes at a cost of $1.62 (exclusive of labor, but including depreciation); the circular weld at the convex end required 2.67 hours and cost $6.99; the circular weld at the concave end required two hours and cost $5.24. At thirty cents per hour, the labor cost would be about $1.63, making a total cost of $15.48. These tanks are used at a maximum working pressure of three hundred pounds per square inch. A water cooled torch was employed in part of this work.

Autogenous Welding of Copper

While copper is normally tough and ductile, it enters a brittle stage when heated to about 1650 degrees F. This brittleness continues up to the melting point (at about 1930 degrees

oxygen. If, then, instead of a very pure copper we use a phosphor-copper alloy when welding, good results may be expected. A welding powder containing a percentage of phosphorus may also be used to secure a de-oxidation. Investigations along these lines are now being carried on in Germany, the exact results of which are not yet known, but it can be stated, in a general way, that good welding powders for copper can be made of such mixtures as borax, phosphor-natrium and prussiate of potash. The borax is not commercial borax, but that which has been subjected to a high temperature in a crucible and has then been pulverized. Boracic acid may be used in-
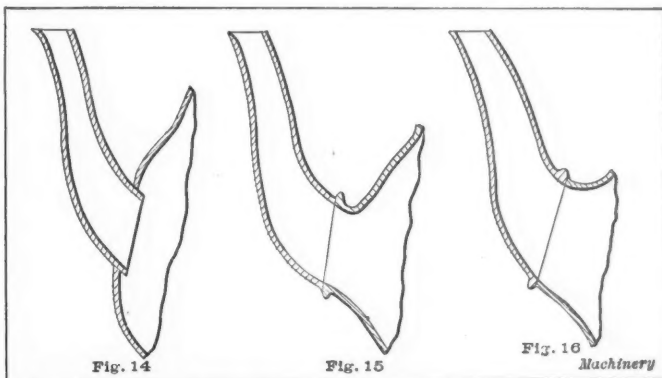
Figs. 14, 15 and 16. Methods of Welding Spouts to Household Utensils

stead of borax. The powder is prepared by mixing the boracic acid and the phosphor-natrium. Welding powders of this description form a film over the work and thus exclude the atmosphere. It is recommended when welding copper sheeting to spread the powder containing phosphorus for about 1½ inch on either side of the joint. This powder is then melted before the welding operation proper is begun. As there is some possibility of blowing away some of the powder when used in this way, it would seem desirable to apply it in the form of a paste.

The Welding of Aluminum

The coefficient of expansion of aluminum is equal to twice that of steel and its melting point compared with that of cop-
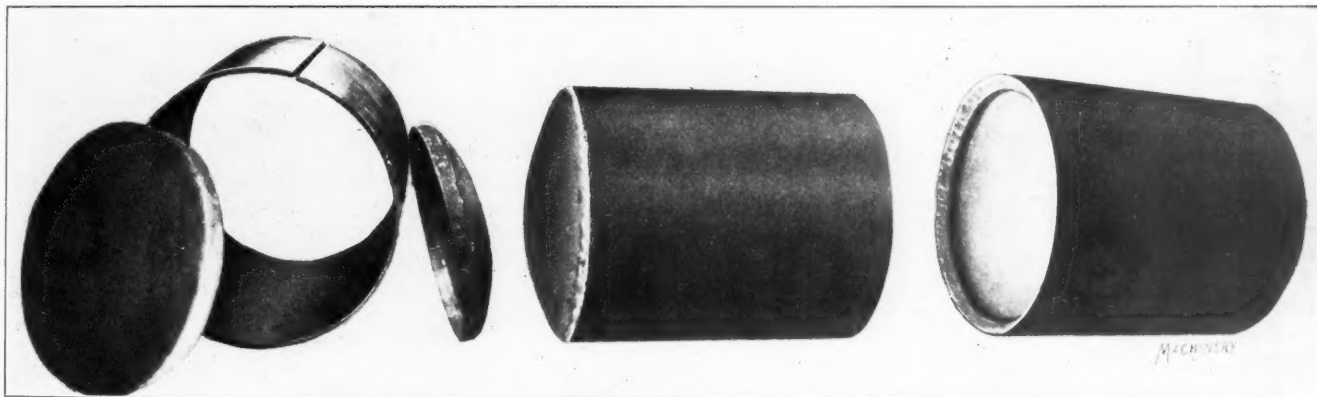
Figs. 11, 12 and 13. Progressive Steps in Making the Tank shown in Fig. 10

F). In order to weld copper it must be heated to this critical stage. At these high temperatures copper possesses a remarkable capacity for absorbing certain gases. If exposed to the atmosphere while at a white heat it absorbs oxygen. Another peculiar quality of copper is that when heated to a high temperature, quenching in water has a softening or annealing effect. Copper that has been highly heated and oxidized will, however, begin to fracture when one commences to hammer it, even if it has been annealed; hence, it is very important to prevent oxidation when welding, and by proper management of the outer flame of the oxy-acetylene torch the operator may succeed in preserving the new copper in the weld from oxidation. To make perfect work, however, it is necessary also to preserve the old copper, and here is where difficulties are met with. On account of the great heat conductivity of copper, a high temperature will be found for some distance on either side of the joint to be welded. Unless the operator can protect this outlying region, the results will not be satisfactory.

It is well known that phosphorus has a great avidity for

per and steel is rather low, being about 1215 degrees F. It is also comparatively weak in tension. Cast aluminum resists a tensional stress of about 10,000 pounds per square inch. Because of this weakness, and on account of its high rate of expansion and contraction, it is a difficult material to weld. As its heat conductivity is high, it is also difficult to localize the region of the high temperature. Oxidation of aluminum, however, can be avoided by the use of a proper flux.

While the total expansion and contraction from 100 degrees F. to the fusion point or welding temperature is about the same for cast iron and aluminum, because of the fact that the fusion point of cast iron is at a temperature about twice that of the fusion point of aluminum, the expansion and contraction, due to temperature changes, take place much more rapidly with aluminum, and the operator must use special care on this account. The low temperatures dealt with when welding aluminum make the pre-heating easier, but the operator must guard against not exceeding the fusion temperature. It is sometimes possible to make slight saw cuts here and there, and thus assist in making the effects of expansion and con-

traction harmless. These cuts, of course, must be repaired when the main operation is completed. Aluminum should never be welded without a flux. If welding is attempted without a flux, little globules consisting of aluminum within and a coating of alumina (oxide of aluminum) will appear. In order to eliminate these by heat, it would be necessary to raise the temperature to the melting point of the oxide of aluminum, which is about 5400 degrees F. A flux consisting of the following ingredients has been recommended: chloride of sodium, 30 parts; chloride of potassium, 45 parts; chloride of lithium, 15 parts; fluoride of potassium, 7 parts; and bisulphate of sodium, 3 parts.

When melting new metal from a rod, it is good practice to keep the rod constantly submerged in the molten bath of the metal in the welding groove, which for aluminum should be much larger than usual. If no powder is used, the oxidation is then confined to the upper surface. The main point to remember when welding aluminum is that the fusion point of this metal is very low; hence, the working flame should be kept further away from the metal than is usually the case
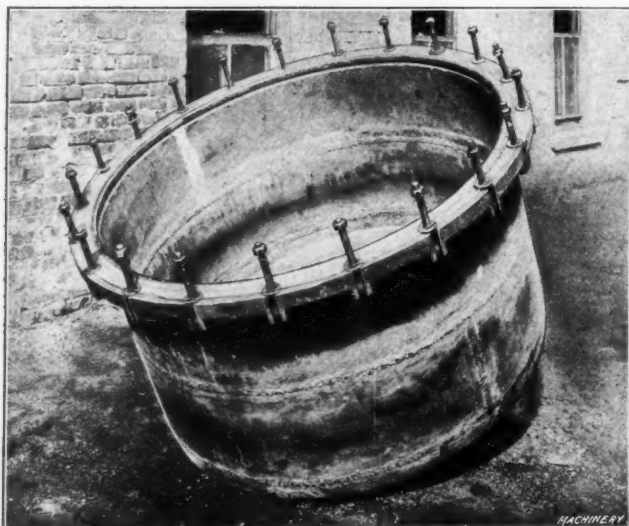
Fig. 17. Example of Welding Copper. Kettle is 5 feet 6 inches in Diameter, 31 inches deep and used under Pressure. All Seams are welded on Both Sides

when welding cast iron and steel. The torch should be so adjusted as to furnish an excess of acetylene. There need be but little fear of carbonizing the metal, for the reason that the temperature of the work is comparatively low.

The Welding of Household Utensils

Some forms of household utensils, such as, for example, coffee and tea pots, cause considerable difficulties in their manufacture, particularly in connection with the attachment of the spout. Soldering has been used to a great extent in making these joints. However, the basic material of the solder is altogether different from the material united. The uses to which the vessels are put expose the joints to the action of acids, and galvanic currents are set up which injure the joint. Aluminum vessels are especially exposed to the action of these currents, because this metal is electro-positive to nearly all of the common metals. One means to obviate the difficulty is to bend the metal of the main vessel or body inwards at the hole for the spout. The material of both body and spout is then bent into a fold on the interior, no soldering material being used. The presence of this fold on the inside, however, is very objectionable. Even though it is closed when the vessel is new, the effect of repeated heatings is liable to open it, and the crevice becomes a trap for various small particles, which prevents effective cleaning. The oxy-acetylene welding presents the best solution of the foregoing difficulties.

When seeking to unite the spout and body by the oxy-acetylene torch, the worker is, however, confronted with several difficulties, especially if the sheet metal be aluminum. The expansion and contraction of aluminum, due to temperature changes, as already mentioned, is very rapid, so that the operator must guard against distortions of the work. The melting point of the metal is low, so that holes are apt to be made in thin metal. Heated aluminum is very readily oxidized with the result that a proper intermingling of the material is diffi-

cult. In view of these facts, it is recommended that the joint be placed away from the main body, that welding wire be dispensed with, and that a suitable flux be employed. In Fig. 14 is shown a joint which eliminates the necessity for the welding wire; the spout fits closely into the hole and is introduced far enough to protrude about ⅛ inch into the interior, the projection thus furnishing the welding material. There is considerable advantage, of course, in thus eliminating the handling of the wire as far as the worker is concerned, and another advantage is that the welding material is precisely the same as the material of the work. It is difficult, however, to operate on the interior, but this difficulty may be reduced by using a tip of special form. The appearance of the exterior, however, is good.

Another form of joint is shown in Fig. 15. Here the diameter of the hole is first made smaller than the interior diameter of the lower end of the spout. The material is then bent outwards to form a ridge of the same diameter as that of the spout end. The body and spout can then be butt-welded by using welding wire. It is preferable, however, to bend the edge of the projection from the vessel outward, thus supplying the needed welding metal, or the auxiliary metal may be provided by bending the edge of the spout outwards, a joint of this kind being shown in Fig. 16. In either case, the ring of metal protruding at the joint will not be thicker than ¼ inch in a radial direction. In both cases, the interior is smooth.

* * *

COST OF MAINTENANCE OF GASOLINE MOTOR TRUCKS

An interesting paper was presented by Mr. Louis Ruprecht, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, on the "Cost of Work with Gasoline Motor Trucks." It may be of interest to quote a few of the figures given, as the motor truck is now looked upon with considerable interest by many manufacturers. The depreciation may be figured at from 10 to 15 per cent per year, the tire value being deducted from the cost of the complete vehicle and the tires considered independently. The drivers' wages on a half-a-ton delivery wagon may be assumed to be about $2.75 per day, and on larger trucks from $3.00 to $4.00 per day. The garage charges, including only the washing and storing of the vehicle, are on an average from $240 to $300 per year, according to the size. The tire cost should be figured on the basis of a life of 8000 running miles, as guaranteed by the makers. The gasoline cost may be taken as about 11 cents per gallon, although at times it may be somewhat higher. Oil may be assumed to be 30 cents per gallon, and one gallon of oil will be sufficient for 50 to 125 running miles according to the size of the vehicle. The insurance will come from $100 to $250 per year according to the size. Repairs and replacements should be figured up to 3 cents per mile in the case of heavy trucks. This figure is based on extensive records.

Based on these figures a table has been compiled which gives, in the first place, the fixed charges per day for different sizes of vehicles, and in the second the additional running cost per mile. For example, the cost of operating a six-ton truck, all charges included, 45 miles per day, will be $6 + (0.1540 × 45) = $12.93. The figures presented by the author also show conclusively that wherever a large tonnage is to be handled it is of the highest importance to use a few large units instead of many small ones.

Size of Vehicle	Fixed Charges	Increment Per Mile
1000-pound	$5.07	$0.0686
3-ton	5.33	0.0860
5-ton	5.60	0.1253
6-ton	6.00	0.1540
7-ton	6.15	0.1718
12½-ton train	7.40	0.2070

* * *

The data on the effect of vanadium in high-speed steel, given in the July number, was erroneously attributed to a publication issued by the American Vanadium Co., Pittsburg, Pa. The data should have been credited to the Vanadium-Alloys Steel Co., Latrobe, Pa.

THE STURTEVANT AERONAUTICAL MOTOR*

By CHESTER L. LUCAS†

Although the past few years have witnessed remarkable achievements in mechanical flight, it is evident, from the constantly recurring accidents, that, at best, aerial navigation is still extremely hazardous. Many of these accidents have been due to motor troubles of some form, and it is generally
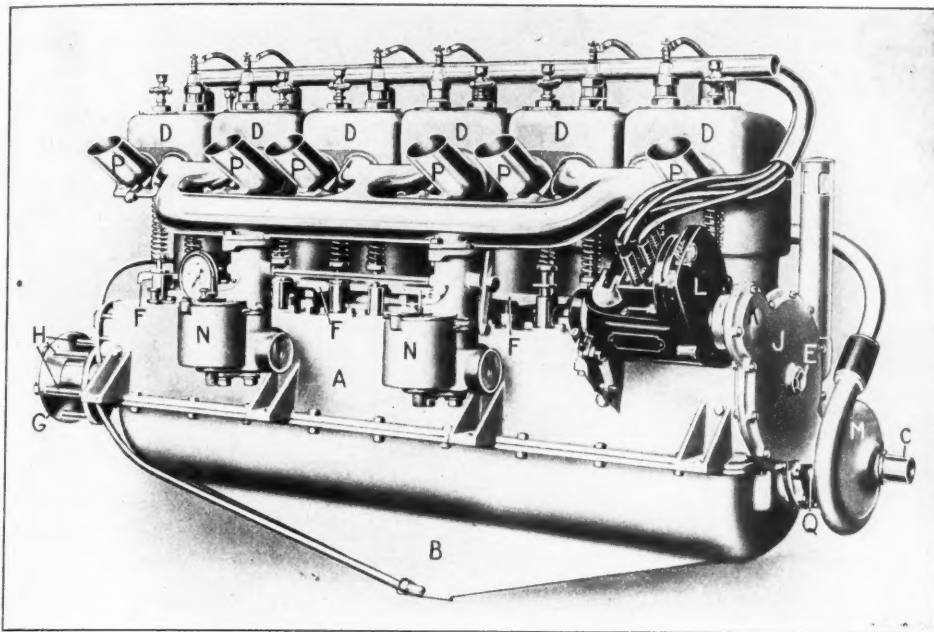

Fig. 1. The Sturtevant Aeronautical Motor, Six-cylinder

admitted that the majority of the present-day motors are inadequate, either through faulty design, poor workmanship or both. In the mad race for a light-weight motor, safety seems to have been almost entirely disregarded by introducing freaky designs and employing unsuitable light-weight

med up in the order of their importance: First it should be capable of continuous satisfactory performance at various angles over long periods; second, it should produce the maximum amount of power for a given weight, at the same time being economical in consumption of gasoline and lubricating oil; and third, it should be refined in appearance and operation, being hooded and muffled so as to be as small a source of distraction to the aviator as possible. This latter consideration is not, perhaps, as important at the present time as it will be in the future of aviation when the use of aeroplanes in war will necessitate that the motors employed be as nearly noiseless as possible, and when aeroplanes become more common it does not seem fanciful to state that there will be active legislation to silence aeronautical motors.

Distinctive Types of Aeronautical Motors

Generally speaking, aeronautical motors may be divided into two distinct classes: namely, those of the rotary type, in which the cylinders are arranged radially and constitute a revolving member about a stationary hollow shaft fitted with an inlet valve, and those of the stationary type in which the cylinders do not revolve. Under this latter head may be included those motors in which the cylinders are arranged vertically and in tandem; those in which the cylinders are placed in the form of a V, commonly known as the V-type; and those in which there are but two cylinders which are sometimes placed directly opposite each other as in the opposed type. Some motors operate on the four-cycle principle, while others are of the two-cycle type. Each of these different forms of motors has qualifications more or less
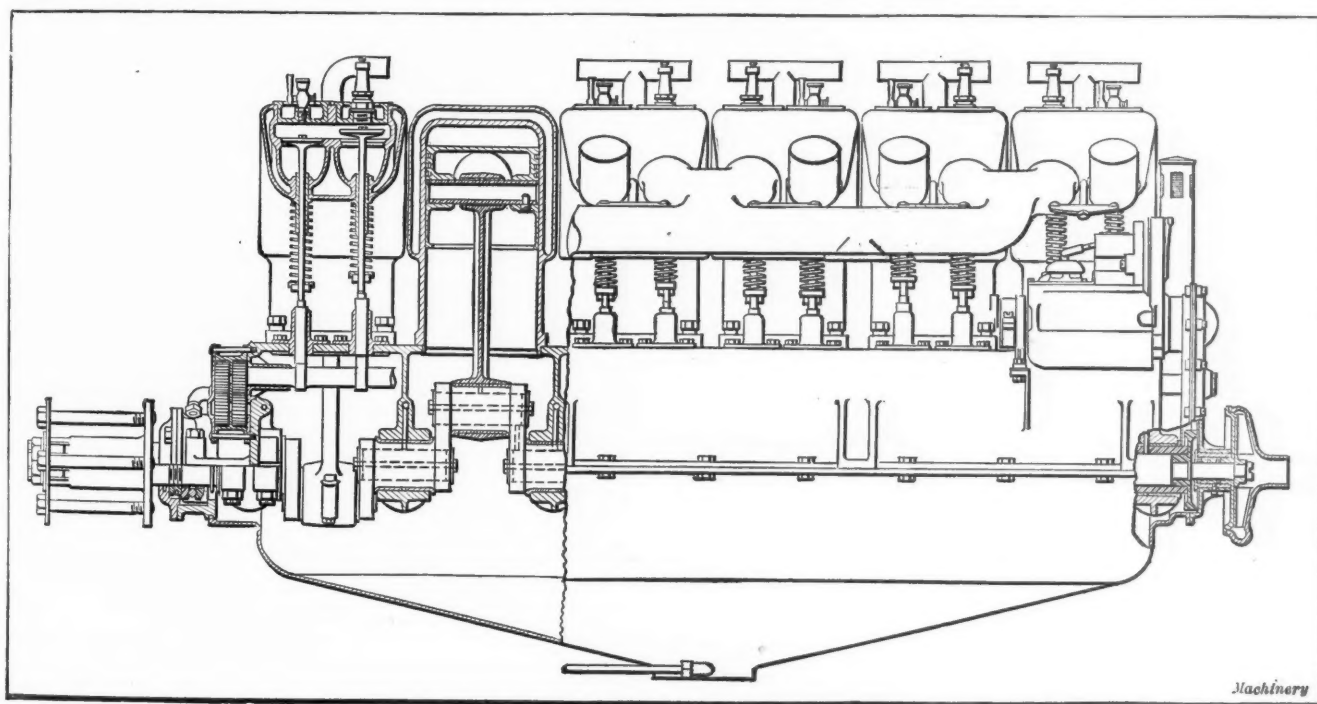
Fig. 2. Construction of Sturtevant Motor, Six-cylinder

materials; moreover, some of the workmanship displayed has been unmechanical, to say the least. The really reliable motors are few in number.

The ideal aeronautical motor should possess certain fundamental qualifications; these qualifications may be briefly sum-

important in its favor, but most of them have objectionable features to offset these qualifications.

The Rotary Type of Aeronautical Motor

Without doubt the rotary type of engine, of which the Gnome make is representative, is at present the most powerful type of motor in proportion to its weight. Its advantages, aside from being of light weight, are that up to certain powers it may be satisfactorily air-cooled; the torque

is exceptionally uniform, due to the fact that while in operation, the group of cylinders acts as a flywheel, so of course no added weight is given to the motor. An additional advantage is present in this type of motor in that all the cylinders are in one plane, thus minimizing the effect of unbalanced forces.

On the other hand, however, the head resistance offered by a motor of this type is considerable; there is a large waste of lubricating oil due to the centrifugal force which tends to throw the oil away from the cylinders; the gyroscopic effect of the rotary motor is detrimental to the best working of the aeroplane, and moreover it requires about seven per cent of the total power developed by the motor to drive the revolving cylinders around the shaft. Of necessity, the compression of this type of motor is rather low, and an additional disadvantage manifests itself in the fact that there is as yet no satisfactory way of muffling the rotary type of motor.

Stationary Type of Motor

The advantages and disadvantages of the stationary type of motor may be summed up by considering the same points
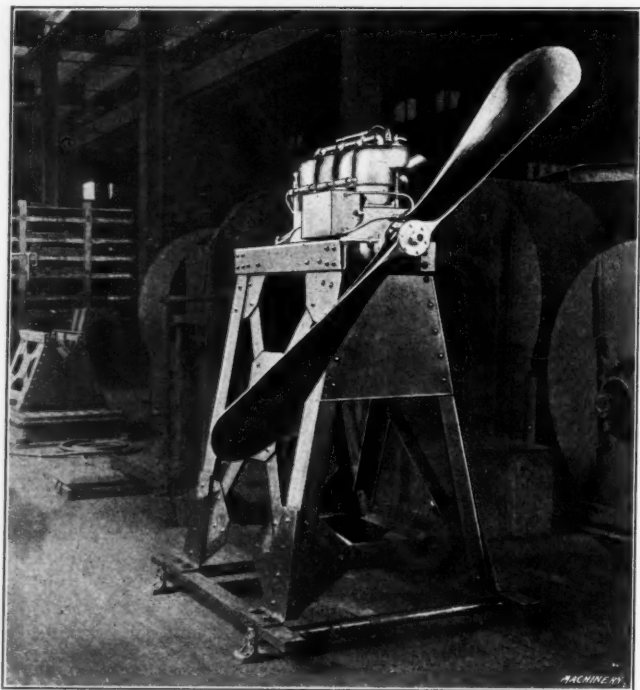
Fig. 3. Four-cylinder Motor mounted on Testing Stand

as set forth in connection with the rotary type. Of necessity, it is heavier in proportion to the power developed; it is not successfully air-cooled, nor is the torque as uniform. The reciprocating movements cause wear and loss of power and except for engines employing six or more cylinders, the balance is not nearly as good in this type of motor.

On the other hand, the head resistance of the stationary type of motor is much less than in the case of the rotary motor; it is very economical in its use of lubricating oil, and it has little gyroscopic effect upon the aeroplane. Less power is consumed in driving a revolving member about the shaft; when water-cooled, the compression may be kept high and it may be satisfactorily muffled, if desired.

While a much simpler motor may be designed by employing the two-cycle principle, its operation is not nearly as satisfactory as the four-cycle, and there are many sources from which trouble may arise. The V-type of motor is usually employed when the cylinders are above six in number, mostly on account of the compactness of this cylinder arrangement. The increased head resistance offered by this type of motor is, however, considerable. The opposed type of motor is seldom used except on two-cylinder engines.

Performances of Various Makes of Aeronautical Motors

The accompanying table has been compiled to show general characteristics and performances of several makes of aeronautical motors. The data used has been furnished by the respective makers of these motors and it is believed that this table should be of assistance to those interested in aeroplane power plants.

The Sturtevant Aeronautical Motor

The Sturtevant aeronautical motor was recently brought out by the B. F. Sturtevant Co., Hyde Park, Mass. Fig. 1 shows
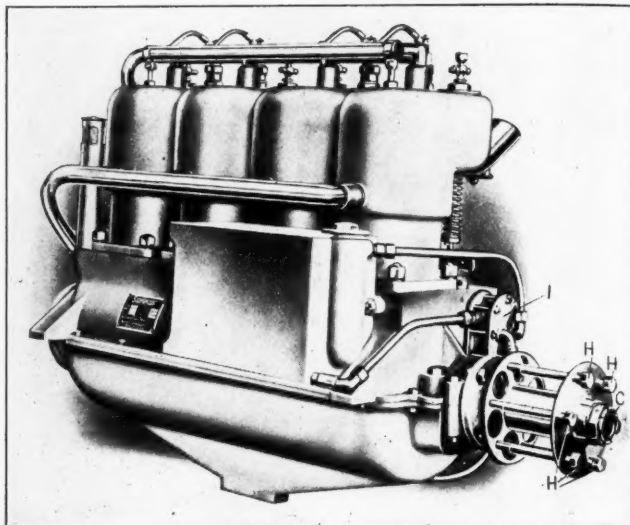
Fig. 4. Rear View of Four-cylinder Motor showing Method of Attaching Propeller

the general appearance of the six-cylinder motor, rated at 60 H. P., and Fig. 2 shows the same motor partly in section. The motor is also built as a four-cylinder type, rated at 40 H. P. This motor is shown in Figs. 3 and 4, and in Fig. 13, where it is set up ready for a propeller test. In designing this motor, the primary consideration was to build an absolutely reliable engine which could be depended upon when making long flights. While the weight has been reduced at every point possible, it has not been done at the expense of strength or reliability. The motor is of the stationary type, having either four or six cylinders. The company has endeavored to make this motor conform as nearly as practicable to the automobile type of motor, for the reason that this type of motor has been found the most practical for general use as evidenced by its employment in automobiles and, though a secondary consideration, it seems to be one which is generally appreciated by the average mechanic.

Crankshaft

The crankshaft which may be seen at C in Fig. 9 and in detail in Fig. 5, is machined from a bar of $3\frac{1}{2}$ per cent nickel steel, containing 0.40 per cent carbon. After being machined, the crankshaft receives two heat treatments and has an ultimate tensile strength of 125,000 pounds per square inch of section. The bearings of the crankshaft are each $2\frac{5}{8}$
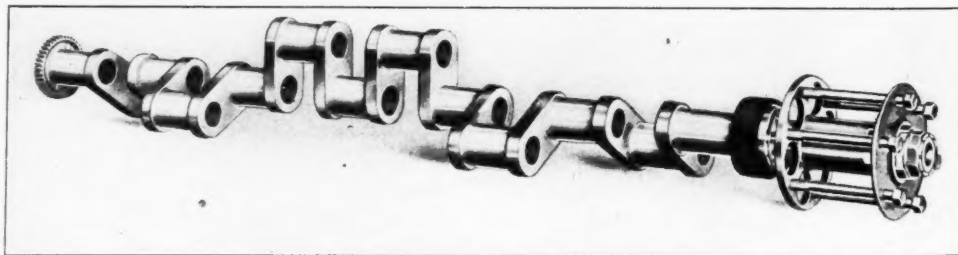
Fig. 5. Six-throw Crankshaft

inches long and are $1\frac{3}{4}$ inch diameter, the pins also being of the same dimensions. In order to lighten the crankshaft as much as possible, the pins and bearings are drilled and bored, the drilling operation being shown in Fig. 10, and the boring operation being illustrated in Fig. 11. The drilling of the pins and journals is accomplished by strapping the crankshaft to a suitable base located upon the Prentice Bros. drilling machine as shown. The boring to size is done in a

lathe by means of special boring-bars of the proper sizes. It is interesting to note that in finish-boring the crankshaft, the diameters of the holes in the successive journal bearings decrease regularly commencing with the first cylinder, which is bored to a diameter of 1⅜-inch and thence down to the sixth cylinder which is bored to a diameter of 1 inch. The reason for this is that at the driving end of the crankshaft, it is not necessary that there be as much strength as at the position of the sixth bearing where the power delivered by all six of the connecting rods is being transmitted. The pins are bored uniformly in order to preserve the balance of the crankshaft. These hollow pins and journal bearings are connected by drilled cross holes, and by closing the ends of the holes in the journals and pins by suitable caps *R*, shown in Fig. 9. The crankshaft is thus provided with a lubricating duct through which oil may be pumped. Fig. 12 shows the operation of grinding the pins and journals on a Norton grinding machine. The propeller end of the crankshaft is fitted with a ball thrust bearing shown at *T*, Fig. 9, which may be arranged to take the thrust in either direction as desired. The method of attaching the propeller is worthy of noting. The end of the crankshaft which receives the propeller is slightly tapered; a flange *G*, Fig. 1, is provided having six holes to correspond with the attaching bolts *H*, and the opening in the flange is castellated to slide over the end of the shaft which has, in turn, been castellated to receive this flange. Thus, by means of the flange the propeller is supported from both sides and the tendency of shearing the attaching bolts is distributed over both ends of the hub.

Connecting-rods

The connecting-rods are made from drop-forgings of 3½ per cent nickel-steel and are of I-section. The bearings are die-cast bushings of Parsons white brass. When it is stated

treated in accordance with the S. A. E. specifications. The connecting-rod caps are adjusted in position by the use of shims of laminated metal. Pieces of this metal are shown in Fig. 14 and, as will be seen, the metal is about 3/32-inch thick, and is composed of many thicknesses of thin sheet brass, each 0.002 inch thick and sweated together with soft solder. Successive layers of the metal may be easily pulled off as required in adjusting the boxes.

Pistons

The pistons, one of which is shown in Fig. 6, are cast from semi-steel having a tensile strength of 40,000 pounds.
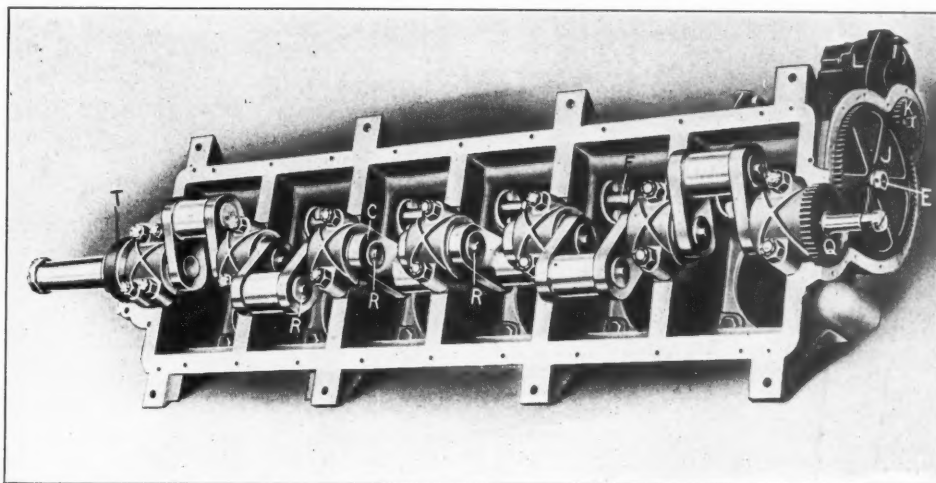
Fig. 9. Crankshaft and Base, showing Method of Mounting

The exterior of the piston is ground and balanced to within two drams of standard weight. This balancing is done by removing metal from a boss which is left projecting within the interior of the piston, enough metal being removed to bring the pistons to standard weight. The piston rings are cast iron, of the ordinary type and are three in number. The piston pins are of 3½ per cent nickel steel and are bored hollow to reduce weight.

Cylinders

The cylinders, as shown in Fig. 7, are of the L-type, having the exhaust and intake valves located on the same side. An important reason for selecting this type of cylinder lies in
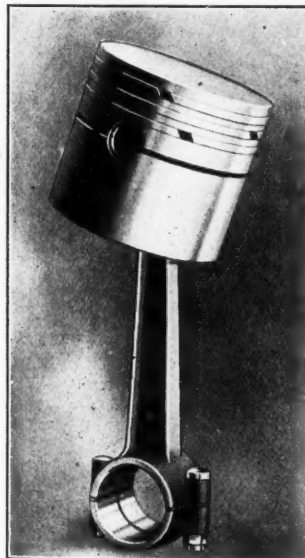
Fig. 6. Piston and Connecting-rod   Fig. 7. Cylinder   Fig. 8. Lubricating System Pump
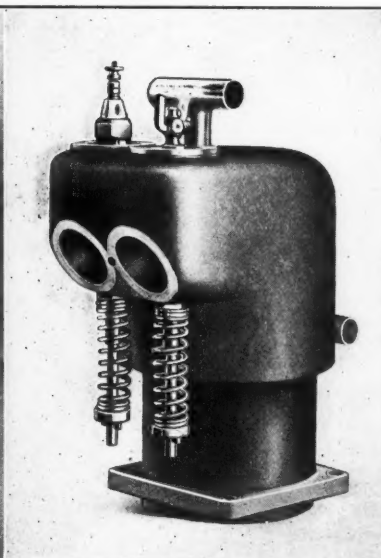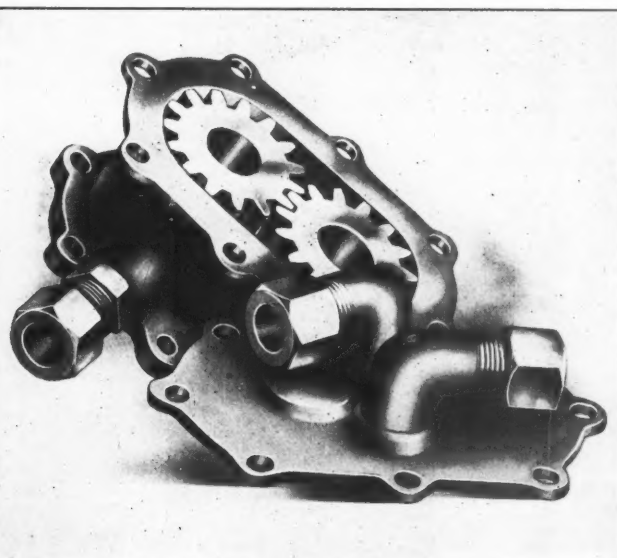
that some connecting-rods are made of non-ferrous metals it will be readily understood how inadequate they must be for use as aeronautical motor connecting-rods, and it is little wonder that they will not do the work required. Sturtevant connecting-rods are balanced with respect to the center of gravity, being placed on balances with opposite ends together; that is, the large end of one connecting-rod, together with the small end of another connecting-rod, is placed in the pans on one side of the balances, while the opposite ends are placed in the pans on the other side of the balances. Before being machined and balanced, the connecting-rods are heat-

the fact that with the straight cylinder which has been used to a large extent on aeronautical motors, there is always danger from broken valve parts being caught in the cylinder and causing damage to the motor. Of necessity, on cylinders of this type, the water jackets are cast integral. Experiments have been conducted in electro-depositing copper jackets, but so far, at least, the integral jacket seems to be the most satisfactory. The metal from which the cylinders are cast is the same semi-steel mixture from which the pistons are cast, and, of course, the jackets are made as thin as it is possible to cast the metal. After being machined, the cylinders are

hydraulically tested to 600 pounds per square inch. They are then heat-treated and accurately ground. The ratio between the stroke and the bore of these cylinders is 1 to 1, the stroke and bore each being 4½ inches. Upon this point of cylinder design there seems to be a difference of opinion,
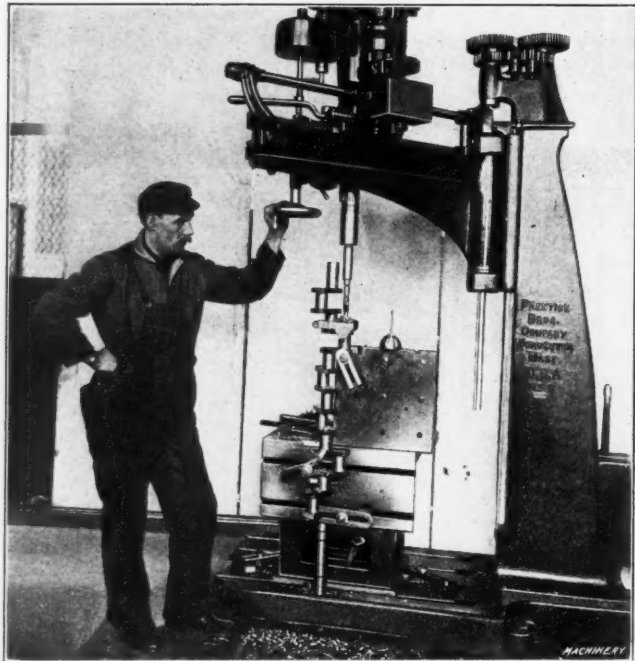
Fig. 10. Drilling out the Pins of the Hollow Crankshaft

some designers being in favor of long stroke motors, while others consider the short stroke to be the better.

Camshaft, Valve Mechanism and Other Parts

The camshaft, a portion of which may be seen at E, Fig. 9, is turned and ground from nickel steel, being ground with the Norton cam-grinding attachment. Previous to being finish-ground the camshaft is pack-hardened. Upon the forward end a gear J is mounted which transmits motion from the gear Q on the crankshaft to give rotation to the camshaft. This gear J also acts as an intermediate gear in the driving

Means are provided for starting the motor in mid-air; this is an advantage in that it will enable an aviator to shut off his motor while "volplaning," and yet be able to start it again at will without landing. Referring to Fig. 1, at F may be seen a valve-lifting rod whose function it is to lift the exhaust valves, should the motor stop while in flight. By thus lifting the exhaust valves, the action of the air on the propeller will cause the motor to start automatically. The base of the motor, indicated at A, is a strong aluminum casting reinforced throughout and the cylinders are held to this base by means of four bolts, each of which passes through flanges on the cylinder bases. The construction of this base is illustrated in Fig. 9, and as will be seen, the bearings for the crankshaft are bolted to the under side. These bearings are die-cast bushings of Parsons white brass. The oil pan
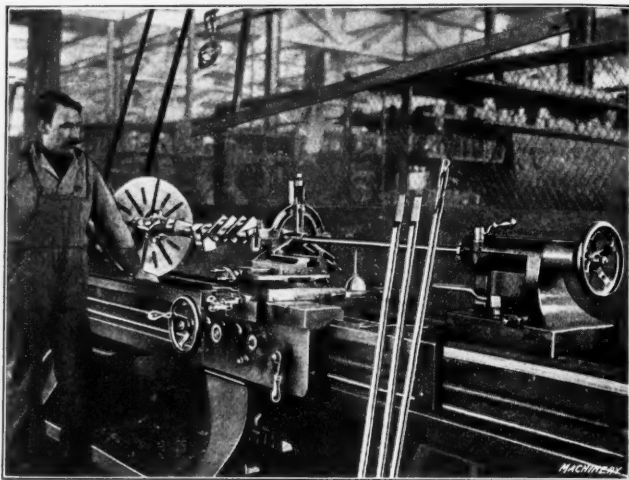
Fig. 11. Boring the Journal Bearings

or sump B shown in Fig. 1, is of slightly different design than that ordinarily used. As the deepest point is at the center, the oil will gravitate toward the center of the sump, even though the motor be operating in an inclined position.

Lubricating System

The lubrication system employed in the Sturtevant aeronautical motor is of more than ordinary interest. The funda-

COMPARATIVE DATA ON LEADING AERONAUTICAL MOTORS

Name	Rated H.P.	Speed*	Dev. H.P.	Weight	Wt. per H. P.	Type	No. Cylin.	Cycle	How Cooled	Gaso-line†	Lub. Oil†	Prop. Diam.	Prop. Pitch	Prop. Thrust	List Price
Sturtevant	40	1200	46	200	4.34	Vert.	4	4	Water	4.87	0.303	7′ 6″	4′ 6″	375	1500
Sturtevant	60	1200	69	300	4.34	Vert.	6	4	Water	7.31	0.455	8′ 0″	5′ 0″	450	2000
Hall-Scott	40	1250	35	160	4.57	Vert.	4	4	Water	3.50	1.000	7′ 0″	5′ 0″	300	1500
Hall-Scott	60	1250	70	265	3.78	V	8	4	Water	7.00	1.500	7′ 6″	5′ 0″	400	2250
Hall-Scott	80	1250	70	290	4.14	V	8	4	Water	7.00	1.500	7′ 6″	6′ 0″	500	2750
Gnome	50	1200	42	167	4.00	Rot.	7	4	Air	4.00	0.375	7′ 6″	7′ 0″	420	3000
Gnome	70	1200	63	212	3.35	Rot.	7	4	Air	6.00	1.000	8′ 0″	8′ 0″	500	4000
Renault	50	1800§	59.4	420	7.07	V	8	4	Air						3200
Renault	70	1800§	79.8	453	5.66	V	8	4	Air						3700
Gyro	50	1200	48	165	3.30	Rot.	7	4	Air	4.25	1.500	7′ 9″	5′ 2¼″	420	2000
Roberts	50	1200	51	170	3.33	Vert.	4	2	Water	6.00	0.133	7′ 6″	5′ 3″	320	1500
Roberts	75	1200	70	270	3.43	Vert.	6	2	Water	9.00	0.200	8′ 6″	5′ 6″	480	2200
Curtiss	40	1100	45	175	3.90	Vert.	4	4	Water	4.20	0.750	7′ 0″	6′ 0″	310	1200
Curtiss	75	1000	78	285	3.65	V	8	4	Water	7.2	1.2	7′ 6″	8′ 0″	500	2200
Kirkham	50	1300	54.5	235	4.31	Vert.	6	4	Water	5.00	0.33	7′ 2″	5′ 0″	410	1400
Kirkham	35	1300	38.3	180	4.83	Vert.	4	4	Water	3.68	0.21	6′ 10″	4′ 6″	300	975
Kirkham	70	1680	76.3	285	3.40	Vert.	6	4	Water	7.71	0.42	8′ 0″	8′ 0″	500	1650
Adams-Farwell	72	1000	80	285	3.56	Rot.	5	4	Air		0.5	9′ 6″	6′ 6″	460	2500
Adams-Farwell	125	‡			2.25	Rot.	6	4	Air		0.75	9′ 6″	6′ 6″		3000
Trebert	100	1000	90	350	3.70	V	8	4	Water	8.75	0.25	8′ 0″	8′ 0″	450	1500
Trebert	50	900	50	250	5.00	Rot.	6	4	Water	5.25	0.15	7′ 6″	7′ 6″	250	2000
Maximotor	50	1050	50	210	4.20	Vert.	4	4	Water		0.50	7′ 6″	4′ 6″	360	1200
Maximotor	75	1350	75	320	4.25	Vert.	6	4	Water		0.68			400	1600
Maximotor	70	1350	70	270	3.86	Vert.	4	4	Water						1500
Maximotor	105	1350	105	390	3.83	Vert.	6	4	Water						2000

* Recommended by manufacturer.   † Consumption in gallons per hour at developed H.P.   ‡ Cylinders revolve 800 R.P.M. in one direction and crankshaft 1000 R.P.M. in opposite direction. Both are direct-connected to two propellers.   § Propeller revolves at one-half engine speed or 900 R P.M.

train which operates the magneto L, Fig. 1. These parts are also shown in Fig. 9. The camshaft is supported throughout its length in phosphor-bronze bearings. The inlet and exhaust valves for each cylinder, made of 30 per cent nickel steel, are located in the pockets cast integral with the cylinders. The exhaust pipes are shown at P in Fig. 1. The water pump, M, Fig. 1, is attached directly to the end of the crankshaft, the inlet C being coupled to it.

mental idea in designing this system was to provide a method of lubrication that would be absolutely dependable. By means of a pressure pump shown in Fig. 8, driven directly from the end of the camshaft, the oil is forced through cored holes in the base and into the hollow crankshaft already described. It is thus distributed to the bearings in which the crankshaft runs, and also to the connecting-rod bearings. From these points the oil flies in a fine spray to all parts

of the mechanism enclosed within the crank case, finally gravitating to the sump. Mounted in tandem with the first pump is a second pump. This pump is of slightly greater capacity and its function is to remove the oil from the sump, force it through the oil filter and into the tank ready to be used again. As this second pump is of slightly greater capacity than the pressure pump, the sump is always kept drained, and, moreover, as the filter is in advance of this pump, the oil is *forced* through the filter. In the event of the filter becoming clogged, the pump would exert sufficient force to burst the filter and prevent the lubrication system from failing. These pumps are shown detached from the motor in Fig. 8.

The lubricating oil storage tank holds sufficient oil for three
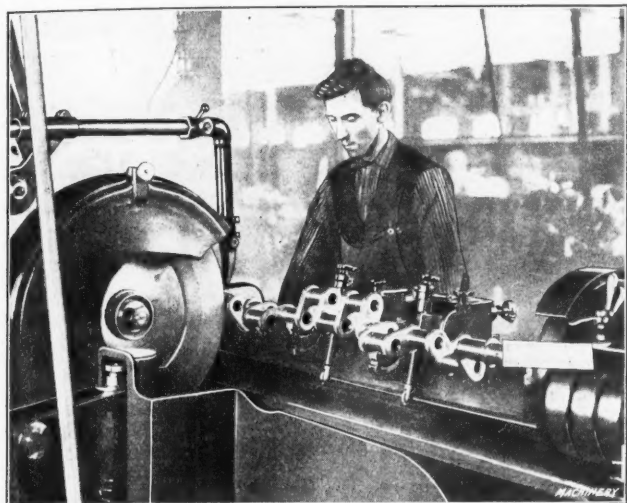
Fig. 12. Grinding the Crankshaft

hour's use and by virtue of the form of sump employed, there is no danger of overlubrication of the end cylinders when the motor is being operated continuously at an angle, since the sump is kept drained of its oil by means of the pump. The 40 H. P. motor requires 0.3 gallon of lubricating oil per hour's run.

Muffling

The subject of muffling aeronautical motors seems to have been an after-consideration with most manufacturers. The
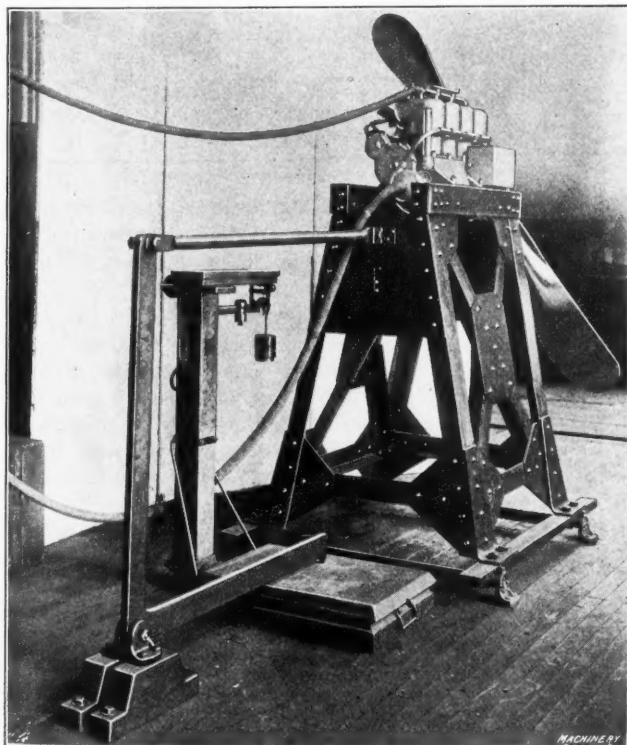
Fig. 13. Sturtevant Engine set up for a Propeller Test

Sturtevant muffler is a part of the power plant and can be shipped with the motor, or if ordered at any future time can be easily applied. It is very probable that in the near future no aeronautical motor which cannot be efficiently muffled will have commercial standing. As a forerunner of this view, the

design of the Wright engine has recently been changed in order that it may be muffled. The Sturtevant muffler can be instantly detached from the motor when not required, and as its total weight is but eighteen pounds, it does not seri-
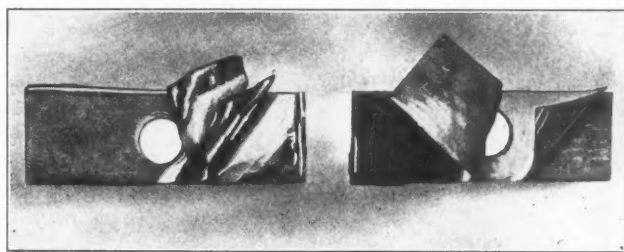
Fig. 14. Laminated Metal

ously handicap the aviation equipment. The loss of power due to the muffler is about five per cent.

Carbureter

The carbureters employed on this motor are of the Zenith make. An advantage claimed for the Zenith carbureter over other makes lies in the fact that after once being set no adjustment is required. Provision is also present for furnishing the carbureter with hot air from the exhaust, so that there will be no danger from freezing of the mixture in high altitudes. The carbureters may be seen at N in Fig. 1.

Tests

In addition to flying tests which have been conducted with the Sturtevant motors, interesting shop tests are being made from time to time. One of these tests was conducted over a period of 100 hours, the motor being operated for twelve consecutive days, 8 hours per day for 11 days, and 12 hours on
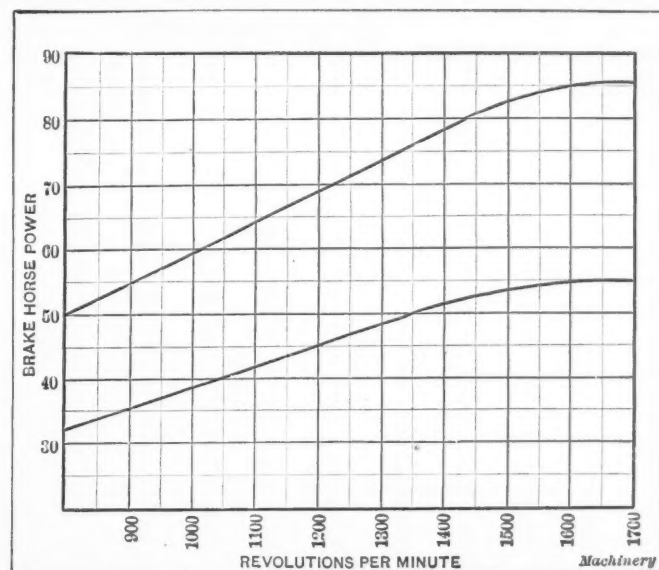
Fig. 15. Power Curves of Six-cylinder (Upper) and Four-cylinder (Lower) Motors

the last day. The motor used was four cylinder, 40 H. P., equipped with a 7½ foot diameter 4½-foot Sturtevant propeller. It developed brake horsepower as indicated upon the power curve chart shown in Fig. 15. During this test an average thrust of 360 pounds was recorded, the speed on the propeller being 1200 revolutions per minute. The only attention which the motor received was the cleaning of the spark plugs and the supplying of oil and gasoline to the tanks at the end of each day's run.

Referring to the power chart, Fig. 15, the comparison of A. L. A. M. ratings with the actual performances of these motors is very interesting and shows exceptionally high efficiency. The A. L. A. M. rating assumes a piston speed of 1000 feet per minute, with which speed the 4½-inch motor necessitates 1332 R. P. M. At this speed the four-cylinder motor is rated at 32 H. P., while its actual performance at 1332 R. P. M. is 50 H. P. The A. L. A. M. rating of a six-cylinder motor is 48 H. P., while the motor actually develops 76 H. P., at 1332 R. P. M. In both cases the peak of these power curves is reached at 1700 R. P. M., at which speed they develop 55 and 86 H. P. respectively.

BALL AND ROLLER THRUST BEARINGS*

By ROBERT H. GRANT†

In the early development of so-called "anti-friction" thrust bearings, there was no data with which the engineer could begin to work, and the great difference between the point bearing of a ball and the surface bearing of a collar or washer was not generally appreciated. In a great many cases, therefore, the early bearings were poorly designed and were made of materials which were not adapted for the purpose. Hence, they were often condemned by the user, and a general opinion was created that they were almost worthless; in fact, if the bicycle, which became so popular simply on account of the introduction of ball bearings, had not been a great factor in counteracting the hostile feeling, the adoption of ball and roller bearings in many fields would undoubtedly have been much slower. The automobile, the development of which followed immediately upon the bicycle, added to the favor with which ball bearings were received.

When ball bearings were first introduced, grinding machines were used to a very small extent, except as tool-room appliances. Hence, the bearing surfaces of the first ball bearings

Figs. 1 to 3. Evolution of the Ball Thrust Collar

were simply polished, and the balls touched only on the "high spots," producing a bearing which did not work smoothly and which soon wore out of true. This also accounts for the unfavorable results obtained with early ball bearings.

Early Development of Ball Thrust Collars

The first and simplest ball bearing made was that known as the "thrust collar." In 1888, Simonds Rolling Machine Co. made a worm-driven machine and experienced considerable trouble with the end thrust of the worm. This company manufactured balls at that time and decided to try a ball thrust bearing for the worm. The thrust collar, as it was first made, consisted of two washers, with two rows of balls
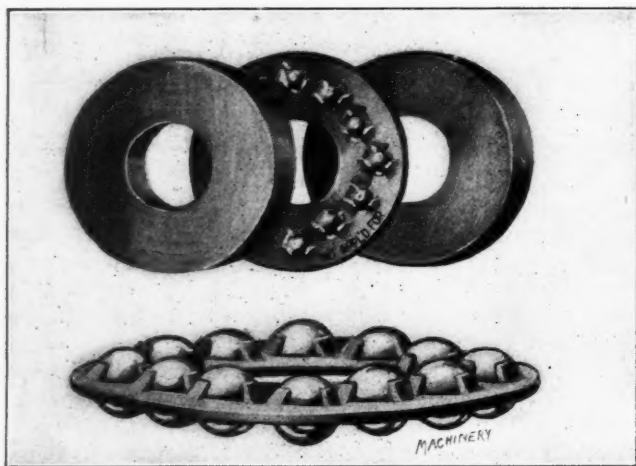
Fig. 4. Pressed Steel Ball Retainer of the Type made by the Pressed Steel Mfg. Co., Philadelphia, Pa.

and two rings, as shown in Fig. 1. In assembling this bearing, the washer was first placed upon the shaft against the bearing collar or shoulder and then the small ring was placed on the washer, after which a row of balls was placed between the shaft and the ring. The second ring and row of balls

* For information on ball and roller bearings, see the following articles previously published in MACHINERY: "Some Notes on Ball Bearings." May, 1909, engineering edition, and also other articles there referred to. See also MACHINERY'S Reference Book No. 56, "Ball Bearings."
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were then placed upon the washer, after which the second washer was put on the top. The washers and balls had to be held together by one man while another man put the shaft in place. However, the bearings often came to grief by the balls falling out, and it was therefore suggested that a soft steel washer of the same diameter as the hardened bearing washers be drilled with holes slightly larger than the balls. This washer would then act as a retainer and keep the balls in place. Experiments were made and it was found that this

Fig. 5. Spinning Tool used in the Manufacture of Ball Cages

method worked satisfactorily. This type of bearing is shown in Fig. 2.

After this style of cage had been used for some time, a further improvement was made in that the holes in the cage were not drilled quite through, but as shown in Fig. 3, so that the balls could not fall through the retainer. This aided the assemblers in handling the balls in the cage without losing them. A groove would soon wear in the washers, however, and in order to cover as much of the surface of the washer as possible with the balls, the balls were later staggered in the cage so as to distribute the load and wear over a greater part of the washer surface.
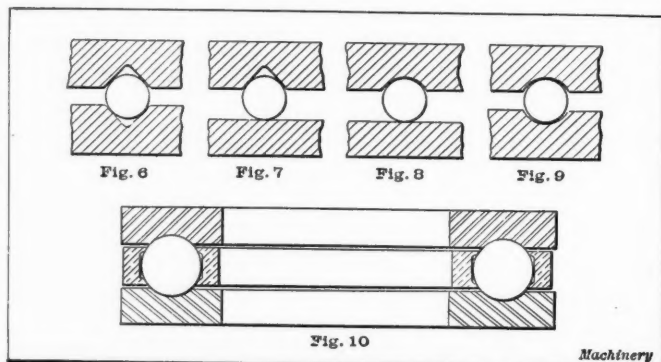
Figs. 6 to 10. Different Types of Grooves for Balls

The Standard Roller Bearing Co. of Philadelphia made its first retainers by drilling holes in the periphery of the washer, and after the balls had been inserted in each hole, the edges of the holes were peened over at the outside. The drill, of course, was somewhat larger in diameter than the thickness of the washer, so that the balls could project on the sides of the retainer. The balls were thus arranged in a radial line from the center of the washer, but were not staggered, so that each row of balls took the same circular path. The generally adopted cage is now pressed out of sheet steel and the openings made of such a size that the balls can be sprung into them by a slight pressure. Such a cage is shown in Fig. 4. In special bearings the cage is made of brass and the holes are drilled the size of the balls. They are not drilled quite through, however, and after the balls have been inserted the holes are spun over with a tool of the type indicated in Fig. 5. The spinning edge A of this tool is hardened. The end of the plunger at B is concave so as to center the tool with the ball. At C is a shoulder on the plunger which is a sliding fit in the hole, thus keeping it straight; D is a collar held in place by a headless set-screw, which retains the plunger; E is a spring which presses the plunger forward and allows it to recede while in operation.

Thrust collar washers can be made either from bar stock in an automatic screw machine with a multiple cutting-off tool, or from punchings. The latter method is the preferable one, as the sheet steel is rolled lengthwise and the grain or fiber

is so arranged that the point bearing of the ball does not come in contact with the ends of the fibers, as it does when the washers are cut in the automatic screw machine. The punched washers, therefore, have from 35 to 40 per cent better wearing qualities than the other type. The thrust collar is not used for heavy loads except in special cases, and the washers are, therefore, seldom made of tool steel, but of case-hardened machine steel. As the washers are perfectly plain, a number of them can be put at a time on a magnetic chuck and can easily be ground parallel so that all the balls will have a bearing and take their share of the load. Table I gives the loads and speeds recommended by the ball bearing manufacturers.

Grooved Ball Thrust Bearings

The grooved ball thrust bearing can be made with grooves of different shapes, but the round groove is the only one to be recommended. In Fig. 6 is shown a thrust bearing with V-grooves. It is difficult to get the grooves in the two wash-

TABLE I. GENERAL DIMENSIONS AND APPROXIMATE LOAD PER
BEARING FOR REGULAR BALL THRUST BEARINGS

Diameter of Bearing, Inches		Diam. of Balls, Inches	Load in Pounds at					
Inside	Outside		1500 R.P.M.	1000 R.P.M.	500 R.P.M.	300 R.P.M.	150 R.P.M.	10 R.P.M.
1¼	2 11/32	¼	350	500	600	750	800	2750
1 7/16	2 15/32	¼	500	600	750	1000	1100	3750
1½	2 21/32	5/16	600	750	850	1100	1350	4000
1¾	3 3/32	5/16	750	850	1000	1350	1750	5000
2	3 11/32	5/16	850	1000	1250	1600	2000	5500
2¼	3 19/32	5/16	1000	1250	1500	1850	2500	7000
2¼	3 23/32	5/16	1100	1350	1750	2100	2750	7500
2½	3 31/32	5/16	1250	1600	2000	2500	3000	9500
2⅝	4 11/32	⅜	1500	1750	2250	2750	5000	10000
2¾	4 15/32	⅜	1750	2000	2750	3000	4200	12500
3¼	4 23/32	⅜	2100	2350	3200	3750	5000	15000
3½	5 7/32	⅜	2500	2850	4000	4750	6000	17500

ers directly opposite each other so that there will be a perfect four-point bearing. Of course a sample bearing in the tool-room can be easily made to meet all requirements, but when the bearings are made in quantities, difficulties are met with. This, however, is not the greatest objection to this bearing. The main objection is that when the load is applied, the ball is squeezed into the V and prevented from turning freely. While the bearing is hardened, it is not glass hard, and it will allow the ball to seat itself so as to wear the bearing out of true in a short time.

In the three-point bearing, Fig. 7, where there is one V and one flat surface, the objections to the V groove are the same
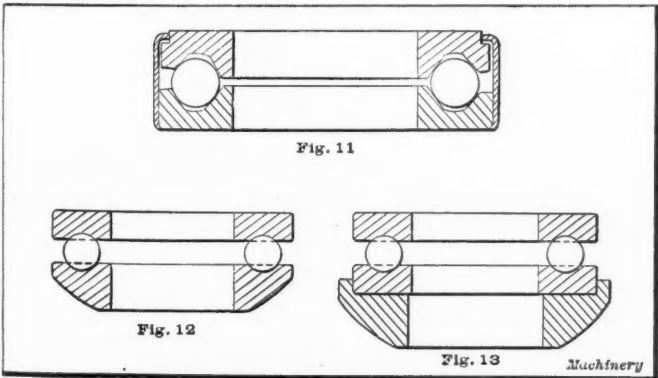
Fig 11. Ball Grooves with Different Angles on the Sides. Figs. 12 and 13. Thrust Bearings with Leveling Washers.

as already mentioned, and the flat surface does not allow a greater load to be carried than that which can be carried by a plain thrust collar. Hence, this bearing is not superior to a regular thrust collar ball bearing, but is more difficult to make; nor is a bearing having one plain and one grooved washer as shown in Fig. 8 superior to a thrust collar. In Fig. 9 is shown the regular grooved ball thrust bearing in its simplest form. The radius of the groove is made from five to ten per cent greater than that of the ball used in the bearing. This allows some latitude for the washers so that they can line up properly. It can be readily seen that

when the load increases on the ball, the surface bearing between the ball and the washer will become slightly greater on account of the fact that the radius of the groove is slightly larger than that of the ball. Theoretically, there is only a point contact when there is no load, but as the load gradually increases this point contact will become a surface contact over a gradually increasing length of the ball circumference.
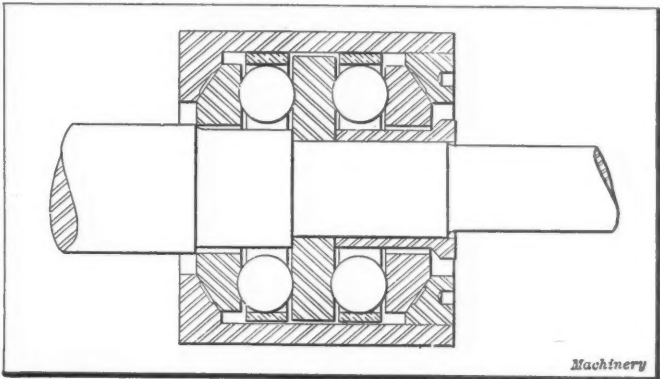
Fig. 14. A Ball Bearing taking Thrust in Both Directions

This makes it possible for the bearing to stand up under heavy loads. But it is difficult to make both grooves bear equally upon the balls unless the bearings are made in a very careful way.

Grooved thrust bearings require the use of a separator the same as the thrust collar. In Fig. 10 is shown the simplest form of retainer for this purpose. When the grooves in the
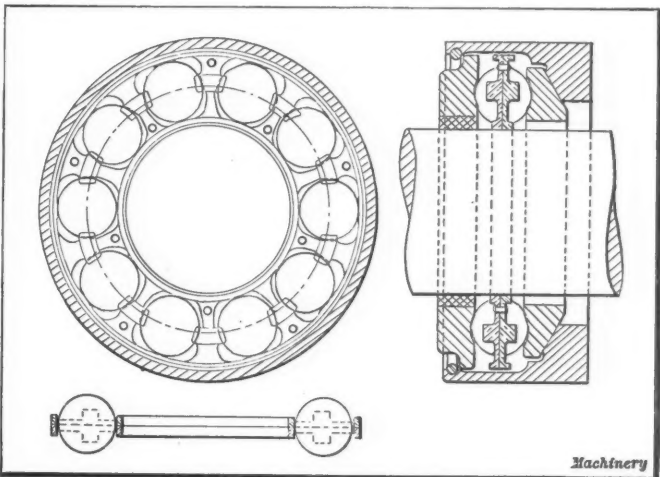
Fig. 15. Skeleton Cage for Ball Bearings

washers are made very deep, the retainers must be made rather thin.

In order to overcome the slippage caused in the V-grooves on account of the inside bearing of the ball running slower than the outside, the Auburn Ball Bearing Co. makes a bearing in which the angle of the V is greater on one side than
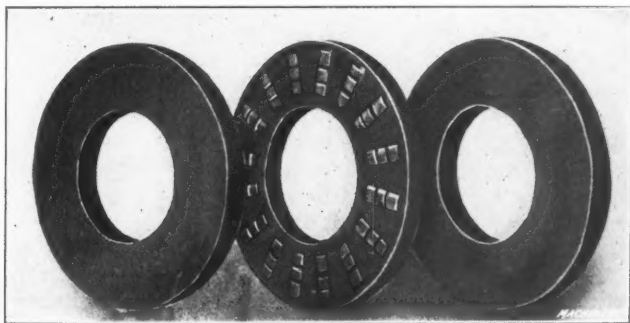
Fig. 16. Simple Form of Roller Bearing

on the other, as shown in Fig. 11. This prevents slippage of the ball, but it does not overcome the squeezing effects of heavy loads. Nevertheless, this bearing has given satisfaction in light and mediumly heavy service.

Applications of Ball Thrust Bearings

For convenience in assembling and handling ball bearings, the self-contained thrust bearing is the most satisfactory. It

is necessary to have the surfaces against which the bearing rests perfectly parallel with each other. Many bearings do not give satisfaction on account of the poor methods employed in their application to the machinery on which they are to be used. In order to overcome the results of neglect on the part of the user, leveling washers are often provided on one side of the bearing to take care of any lack in alignment and insure that the entire surface of the thrust washers will take its proportion of the load. This method prevents breakage and should be universally adopted. It adds but little to the cost of the bearing and saves the user much trouble.
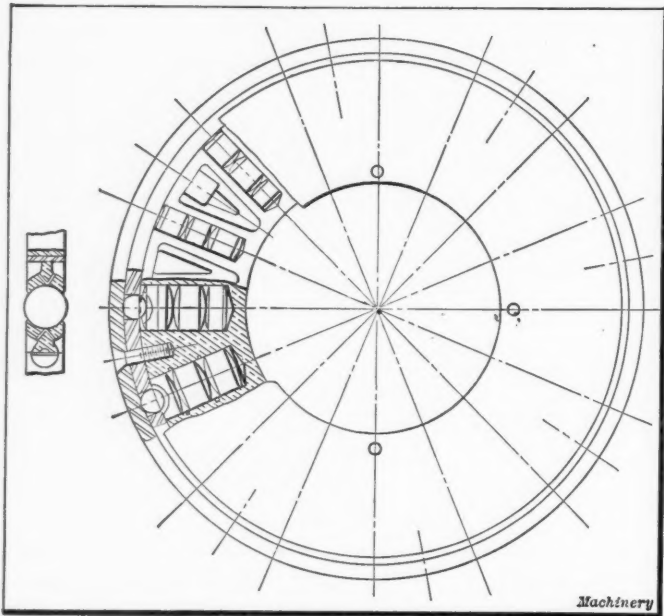
Fig. 17. Means for Taking Care of End Thrust of Rollers in Roller Thrust Bearings

The leveling washer, sometimes termed "radius washer," is made in two ways. In Fig. 12 it is made integral with the lower thrust bearing washer. This is done when the space for the bearing is limited. A corresponding concave surface must, of course, be provided in the housing or part which holds the thrust bearing. If there is plenty of space for the bearing, it is cheaper to use a standard grooved thrust bearing and a leveling washer with a slight recess beneath the lower bearing washer, as shown in Fig. 13.
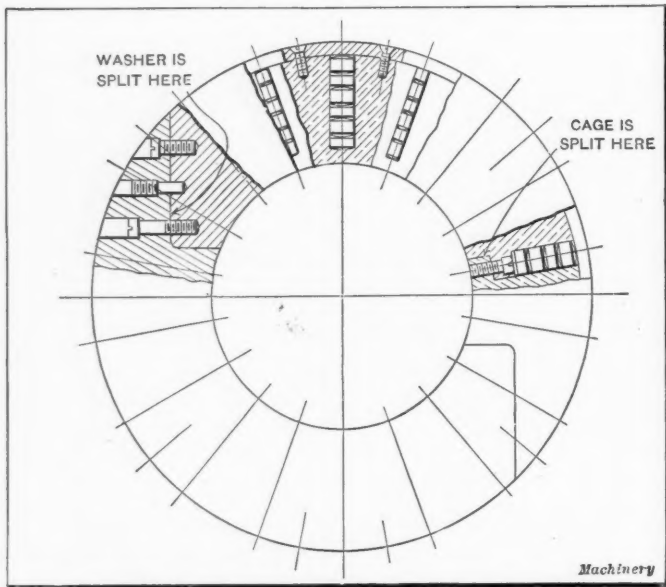
Fig. 18. Plain Roller Thrust Bearing made in Halves

In cases where it is necessary to take thrusts both ways, it is essential to use three washers, the central washer having grooves on both sides and the housing being made with a concave surface at the bottom and having a threaded concave nut at the top, as indicated in Fig. 14, which shows a bearing of very compact design. In high-speed bearings the weight of the cage is often objectionable, and a skeleton cage, as illustrated in Fig. 15, is employed. This cage is made in two sec-

tions, riveted together, and the only surfaces that are finished are those on which the balls and the shaft bear.

Roller Thrust Bearings

The principle of the roller thrust bearing, as shown in Fig. 16, is not theoretically correct, as apparently the rollers must slip to a certain extent. The outer and inner ends of the cylindrical roller roll along paths of different circumferences, and, hence, there cannot be a perfect rolling action. In fact, the rollers follow the path of a polygon with a great number of sides and a slight slippage takes place each time the roller changes its course. From a practical point of view, however, this bearing has proved a great success. Fig. 16 shows the simplest form of plain roller thrust bearing. The rollers are straight and cut into short sections so that they will turn readily. A bearing of this type will sustain loads from four to eight times greater than that carried by a ball thrust bearing of the same dimensions. The slippage that takes place as the rollers change their course in short, jerky movements around the circular path, has proved an advantage in that it partly takes care of the outward thrust caused by the centrifugal force. In large thrust bearings this outward thrust is very great and must be taken care of in other ways besides this.

One of the greatest advantages of this bearing is its simplicity, and the ease with which it can be manufactured. The washers and rollers can be readily ground. A high degree of
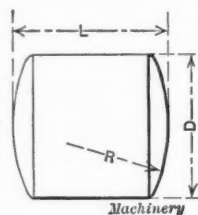
TABLE II. DIMENSIONS OF ROLLERS FOR ROLLER THRUST BEARINGS

	Long Type			Short Type	
Diam. D	Length L	Radius R	Diam. D	Length L	Radius R
1/8	3/32	1/16	1/8	1/16	1/2
5/32	7/64	3/16	5/32	5/64	1/2
3/16	9/64	3/16	3/16	3/32	1
1/4	3/16	1/4	1/4	1/8	1
5/16	15/64	1/4	5/16	5/32	1
3/8	9/32	1/2	3/8	3/16	2
7/16	21/64	1/2	7/16	7/32	2
1/2	3/8	1/2	1/2	1/4	3
5/8	15/16	1	5/8	5/16	3
3/4	9/16	1	3/4	7/16	3
1	3/4	1	1	1/2	4
1 1/8	13/16	2	1 1/8	9/16	4
1 1/4	7/8	2	1 1/4	5/8	4
1 1/2	1	2	1 1/2	3/4	5
1 3/4	1 1/8	3	1 3/4	7/8	5
2	1 1/4	3	2	1	5

accuracy is also possible as all parts can be easily measured. The type of bearing shown in Fig. 16 is made by drilling holes into the periphery of the washer at equal distances around the circumference. The rollers are then inserted, allowing them to project a trifle beyond the sides of the washer; an annular ring or band is then forced onto the washer and is drilled and riveted in place.

The cages, of course, can be made in a great number of different ways. One company makes the slots the full size of the roller and then peens over the sides to retain the rollers. Another company used to make their cages by broaching rectangular holes through the washers and then staking them over to prevent the falling out of the rollers. In all the early types of ball bearings the rollers were all the same length, thereby allowing the roller to cut a path into the washer. To overcome this difficulty two widths of rollers were made, as shown in Table II. It will be noticed that the rollers are rounded on the ends so as to reduce the friction between them. The corners are also slightly rounded so as to prevent crumbling or chipping, which is apt to occur on account of

the slippage of the rollers. With these two different lengths of rollers put into the cage alternately, the whole surface of the washer can be covered.

In fast running roller thrust bearings, it is necessary to take care of the outward thrust of the rollers by placing a ball at the end of the rollers to take the thrust, as shown in Fig. 17. Two bands are placed on the outside of the cage instead of only one; the first band is a soft steel ring and the second is hardened to take the thrusts. The outside roller in each pocket is countersunk to receive the ball. In Fig. 17 is also shown a small section of the cage indicating its skeleton form in order to provide for a light construction. In high-speed horizontal bearings of this class a small thrust bearing
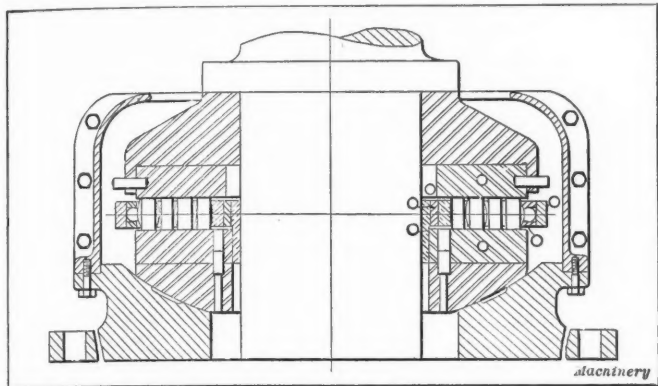
Fig. 19. A Complete Design of Roller Thrust Bearing

is often used to carry the cage. In slower running bearings there is usually a small shoulder on the cage upon which it revolves. Large roller thrust bearings of this class can seldom be used without leveling washers, as already described in connection with ball thrust bearings.

The ordinary form of bearing is made solid, but some are made in halves with all the joints accurately ground, and if properly designed will give as good service as those made from solid plates. The splitting, as shown in Fig. 18, is done in such a way that the rollers pass over the joint at an angle. Bearings made in this way are somewhat more expensive than solid bearings, but are especially desirable in cases where it may become necessary to remove them from the shaft without removing other parts.

Fig. 19 shows a roller thrust bearing with a leveling washer. The bearing washers are made reversible in case of wear. A
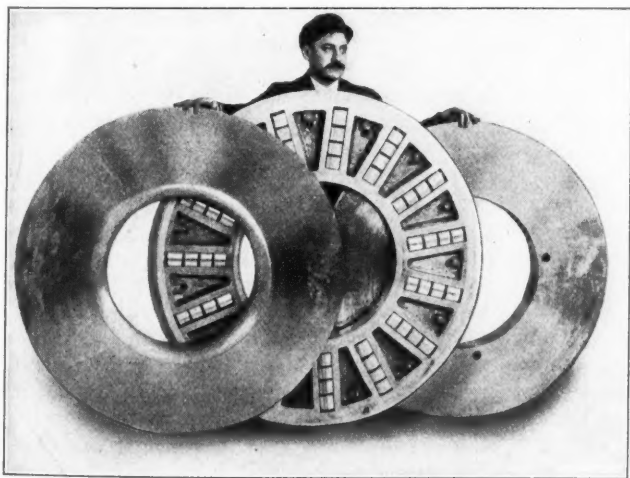
Fig. 20. Example of Unusually Large Roller Thrust Bearing

complete housing is used so that the whole bearing can be run in oil; at the same time the bearing can be easily taken apart, if necessary. The upper washer is held from the outside so as to prevent wear on the shaft. The housing, which is concaved to receive the bottom or leveling washer, is recessed at this joint so as to reduce the bearing surface. This is an example of a compact roller thrust bearing.

As an example of what has been done in large roller thrust bearings, that in Fig. 20 is shown. This is probably the largest bearing of this type ever made and it is installed at the Carnegie Steel Works. This bearing is capable of carrying a load of 1,500,000 pounds running at a speed of 100 R. P. M.

The machine upon which this thrust bearing is used is designed for making steel car wheels by hydraulic pressure. The diameter of the washer of this bearing is 46 inches and the cage diameter, 50 inches. The washers, made from chrome-nickel steel, are 3½ inches thick and weigh nearly 1700 pounds. The cage is made in skeleton form from manganese bronze and is provided with 4-inch chrome-nickel steel rollers. At the end of each set of rollers a large ball is placed to take the outward thrusts, as shown in Fig. 17. These rollers were made from a bar, four at a time, and were not cut entirely apart but simply "necked" so that they would hold together during the hardening process. They were then ground to the same diameter and broken apart and oil grooves ground in the face so as to prevent their cutting the washers. Oil holes were also drilled at the bottom of the recess in the cage from the bore to the pockets which hold the rollers. The pockets in the cage were carefully bored so that the rollers would have a running fit.

For hardening these thrust washers, a track was provided in the furnace, the door of which was made level with the floor, and a truck was made with a table on ball bearings; then a hole was cut in the side of the furnace so that the table could be revolved from the outside. The washers were allowed to heat for ten hours and the table was revolved at certain intervals to insure that they would be uniformly heated. In order to avoid confusion, the men in the hardening room had been previously drilled in removing the washer from the furnace to the hardening tank which was twenty-five feet long, four feet wide and ten feet deep. There was a
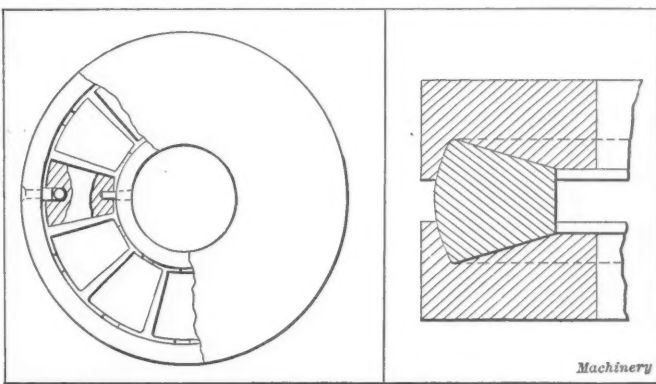
Fig. 21. Tapered Roller Thrust Bearing   Fig. 22. Method of taking the End Thrust in a Tapered Roller Thrust Bearing

track overhead with a pneumatic hoist and two ropes were attached to the hook so that the washer could be pulled back and forth in the water. Seventeen seconds was required for the first washer hardened, from the time it left the furnace until the time it was submerged in the water. It was then raised and lowered by one man while two other men pulled it back and forth in the tank. After the washer was perfectly cold, it was placed in an oil tank over night and upon inspection was found to be perfectly hard. It had warped only about 0.020 inch.

Tapered Rollers in Thrust Bearings

It would seem upon first consideration as if it would be better to use a tapered roller rather than a cylindrical one in a thrust bearing of the type described, in order that a perfect rolling action might be insured. Bearings provided with tapered rollers, however, have not, as far as the writer knows, proved successful, except in very rare cases where the load has been light, or, if the load has been heavy, where the speed has been very slow. The difficulty to be overcome with the tapered roller is the great outward thrust. Several methods have been used to overcome this difficulty. In Fig. 21 is shown a tapered roller thrust bearing with a hardened pin driven into the cage ring and a hole drilled into the end of the roller in which a ball is inserted. This would prove quite successful if every roller were of exactly the same diameter and could be drilled to the same depth, and if all the balls and pins were exactly alike, but, if they are not, the rollers nearest to the center will bear all of the load until some of the parts wear so as to bring the other rollers into action. The rollers must also all be of exactly the same angle, and,

hence, a bearing of this type presents many practical difficulties in its manufacture.

Fig. 22 shows another method by means of which the end thrust of the rollers can be taken care of—that is, by having the washers extend over the ends of the rollers. This, however, is not a practical method for high-speed bearings, as it does not give the roller freedom of action. In cheap bearings, however, this method has proved quite successful. A great many different schemes have been evolved for this class of bearing, such as placing set-screws in the cage ring so that each roller could be adjusted to take its share of the load, etc. Methods of this kind may have worked well for a short time, but as the readjustment has to be done by an expert, the bearings have been considered impracticable for regular use.

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BRITISH ENGINEERING STANDARDS COMMITTEE

In a report by Consul General John L. Griffiths of London, England, a brief history of the British Engineering-Standards committee is given.

The committee was originally appointed in January, 1901, by the council of the Institution of Civil Engineers, to consider the advisability of standardizing various kinds of iron and steel sections. It was then composed of seven members, and the first meeting was held in February, 1901, when it was decided to approach the councils of the Institutions of Mechanical Engineers, Naval Architects, and of the Iron and Steel Institute in order to secure, if possible, their cooperation. These invitations were accepted, and the reorganized committee began work in April, 1901. In November of the same year it was suggested that the standardization of electrical plants should be undertaken, with the result that the Institution of Electrical Engineers was also invited to nominate members of the committee, and in June, 1902, the committee was enlarged.

The work as originally undertaken has thus from time to time been expanded, and numerous subjects have been considered. Some idea of their diversity may be suggested by an enumeration of the several sectional committees. They are: Main; finance; publication and calculations; sections and tests for materials used in the construction of ships and their machinery; steel castings and forgings for marine work; iron for shipbuilding and ships' cables; bridges and building construction; railway rolling-stock under frames and locomotives, with subcommittees on component parts and types, tires, axles, and springs, steel plates, copper and its alloys, iron for railway rolling stock, railway rails, tramway rails, tire profiles, screw threads and limit gages, automobile threads, and also on small screws and screw heads, rolled and drawn sections, keys and keyways, pipe flanges, cement, vitrified-ware pipe, cast-iron pipes for hydraulic power, water, gas, and sewage, heating, ventilating, and house drainage, and for electrical purposes; electrical plant with subcommittees on generators, motors, and transformers, prime movers, physical standards, telegraphs and telephones, cables, electric tramways, and electrical plant accessories. The main committee, with the sectional and subcommittees, now has a membership of 321.

The various original standard specifications are carefully revised from time to time, in order to keep abreast with new inventions and improvements. It is pointed out, on behalf of the committee, that perhaps its most salient feature is the advantage which accrues to Great Britain in that it possesses a central organization from which information may readily be obtained, both as to standards and as to the causes that led to their adoption.

Some fifty-seven reports on various subjects have been published and may be secured at prices ranging from 60 cents to $5.10 each. A minimum subscription of $51.10 entitles the subscriber to a copy of each report as published and of each revised report and to information two or three times a year concerning the various subjects dealt with by the committee and early information of any revisions in hand.

Steps have been taken for holding at an early date—probably in London—a conference on international electrical standardization.

NATURAL ALLOY STEEL*

By E. F. LAKE†

Natural alloy steel is rapidly becoming prominent in the manufacturing field. It derives its name from the fact that the steel is manufactured from an ore in which nickel and chromium are alloyed by nature. While such ores have been known to exist for some time, it is only within the last decade that ores were discovered that had a uniform composition and existed in quantities sufficiently large to warrant their manufacture into steel.

Shortly after the Spanish-American War, such ore was discovered at Mayari and Moa in the Province of Oriente, in the eastern part of Cuba. These ores showed a remarkable uniformity of composition and covered some 25,000 acres on a plateau on the northern slope of a mountain range. In this place there is something like 1,000,000,000 tons of ore in sight, low in phosphorus and sulphur. The Pennsylvania Steel Co., Steelton, Pa., obtained the control of these ore beds and is, besides the Maryland Steel Co. of Sparrows Point, Md., the only company manufacturing steel billets, blooms, bars, and miscellaneous forgings from the ore. The steel made by the Pennsylvania Steel Co. is known by the trade name "Mayari steel." Other companies purchase the billets, bars, etc., and roll and forge them into commercial shapes. The Philadelphia Steel & Forge Co., Philadelphia, Pa., is one of these firms and it has given the product the trade name "natural alloy steel," while the Carpenter Steel Co., Reading, Pa., calls it "Samson steel." Both of these latter firms make a specialty of rolling and forging shapes suitable for automobile parts, but they also manufacture the steel into bars and shapes that can be used for die-blocks, spindles, tools, and numerous other purposes.

Composition

The various grades of steel into which this ore is manufactured contain from 1.00 to 1.50 per cent of nickel; from 0.20 to 0.70 per cent of chromium; and from 0.30 to 1.50 per cent of carbon; the manganese runs from 0.50 to 0.80 per cent; while the silicon is kept below 0.20 per cent and the phosphorus and sulphur below 0.04 per cent. These two latter elements, however, seldom reach 0.035 per cent, and a phosphorus content that is below 0.02 per cent is often obtained. The commercial stock is manufactured into two types, one of which contains between 0.20 and 0.40 per cent of chromium, and the other between 0.40 and 0.70 per cent. Both of these can be obtained in any of the following carbon percentages: 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.50 per cent. Another brand that is used to a large extent for leaf springs, and also for other purposes, contains from 0.90 to 1.50 per cent of carbon and between 0.20 and 0.40 per cent of manganese, which is in accordance with the spring steel specifications of the Pennsylvania Railroad Co. Titanium, vanadium and other purifying materials can be added to the steel if it is so desired, and thus further enhance the physical properties.

These natural alloy steels are carefully made by the open-hearth process and are, in the heat-treated condition, in every way the equal of 3½ per cent nickel steel. In some ways they are superior to this steel and especially is this so of the type that contains the higher percentages of chromium, or when they are manufactured into parts that have a comparatively large sectional area. They are also cheaper than the nickel steels made by the same process, and in the billet form they are but little higher than the ordinary carbon steels. The high-grade and high-priced nickel-chrome steels are the only ones that are superior to the natural alloy steels in static strength, and this is largely due to the fact that they are usually made by the crucible process and contain a higher percentage of chromium, this being approximately 1.00 and 1.50 per cent in the two best brands.

Properties of Natural Alloy Steels

For comparing the static strength, a large number of tests were made with natural alloy, nickel and carbon steels that contained 0.40 per cent of carbon and were hardened at the critical point and then drawn at various temperatures between 500 and 1500 degrees F. The average results obtained from these three kinds of steels are shown in Fig. 1. The steels compared all contain 0.40 per cent carbon. The natural alloy steel was quenched at 1520 degrees F.; the 3½ per cent nickel steel at 1500 degrees F.; and the carbon steel at 1530 degrees F. The average strength of each steel at a given drawing temperature can be obtained by following the line indicated by the desired number of degrees downward, until it meets the curve of the tensile strength, elastic limit, elongation or contraction, according to which is to be found, and from this point following the horizontal line to the left, where the number of pounds per square inch, or the percentage, is recorded. In Table I are shown the average elastic limit and ultimate strength of the fiber stress as ascertained in some torsional tests made at the Pennsylvania State College. All heat-treated specimens were hardened and drawn to develop the best properties for driving shafts, axles, etc.

Much care has to be used in manufacturing the ordinary nickel or nickel-chrome steels to prevent either of these elements from segregating in the bath or when teeming it into ingots. This is largely due to the fact that the nickel and
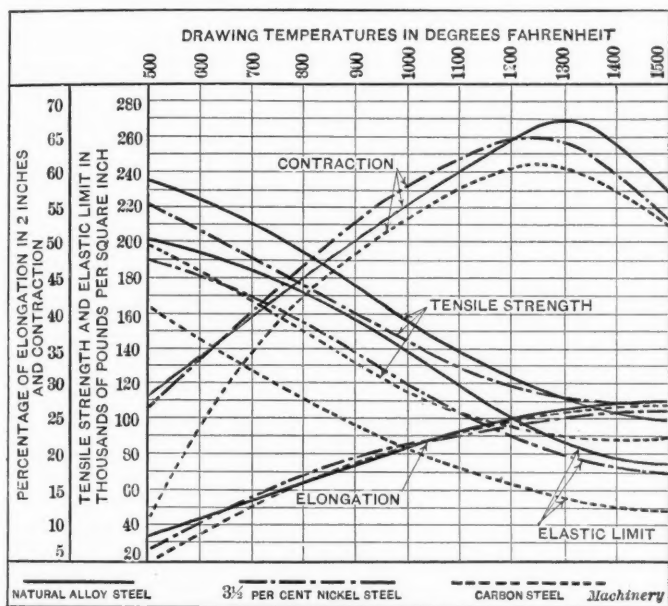
Fig. 1. Comparison of Characteristics of Natural Alloy, Nickel and Carbon Steels

chromium are additions and the bath must be heated to a comparatively high temperature just before teeming. In the natural alloy steel, however, the nickel and chromium are alloyed in the ore and are present in the bath from the time the melting operation starts until the finished steel is poured into ingots. Hence the bath does not have to be heated to any higher temperature at the time of tapping than do ordinary steels, and any tendency towards segregation is largely overcome. Thus, the elements are more uniformly distributed throughout the mass, and a homogeneous metal is obtained. When such elements segregate and the steel is rolled, they produce laminations in the metal which have a very injurious effect upon its strength, especially at right angles to the direction in which they are rolled.

The chromium gives the steel a mineral hardness and refines the grain remarkably, owing to its tendency to prevent the development of a crystalline structure. In the annealed state, every increase of chromium up to a content of 6.50 per cent raises the tensile strength, while the elastic limit is gradually raised until a chromium content of 3.00 per cent is reached. This latter remains constant until the chromium content has passed 9 per cent, but after this a rapid reduction takes place. In the hardened steels, both the tensile strength and the elastic limit increase until a chromium percentage of 5.00 per cent has been reached, and beyond this point both gradually decline. When 2.00 per cent of chromium has been added to a steel

that has a carbon content between 0.75 and 1.50 per cent, it combines great hardness with ability to resist shock. It is one of the best materials for piercing armor plate, and is also used in making projectiles. A chromium content of 3.50 per cent in a tool steel that contains 8.25 per cent of tungsten, gives the steel the well-known property of red hardness; that is, the hardness is not drawn and the cutting edge is maintained when using the tool at a red heat. A high percentage of chromium is also added to a steel that is forged between layers of wrought iron or soft steel and hardened in water. This is used in safes, vaults, etc., to make them burglar proof, and is also used for ploughshares and similar work.

TABLE I.   AVERAGE FIBER STRESS IN POUNDS PER SQUARE INCH OF TORSIONAL TESTS MADE AT PENNSYLVANIA STATE COLLEGE

Kind of Steel		Natural Alloy Steel	3½ % Nickel Steel	Carbon Steel
Annealed	Elastic Limit	41,500	40,800	32,500
	Ultimate	93,400	78,200	75,100
Heat-treated	Elastic Limit	93,600	76,400	60,500
	Ultimate	130,200	108,000	102,400

Extreme hardness may be obtained in chromium steels, as the chromium intensifies the sensitiveness of the metal to quenching and greatly reduces the liability to fracture that is found in carbon steels. This is due to the fact that in chromium steels the critical changes that take place when heating all steels to the hardening temperature take place more slowly. Chromium is also one of the best elements in a steel that is to be carbonized or casehardened, as it greatly increases the susceptibility of steel to heat-treatment and acts as a carrier of the carbon. Thus, in steels containing chromium, the carbon will penetrate to a much greater depth, and a higher percentage will be absorbed by the outer layer in a given time, than with any other kind of steel, especially carbon steel. The increase in depth of penetration of carbon is about 30 per cent of the penetration in ordinary carbon steels.

The extreme hardness produced by chromium makes it necessary to use comparatively small percentages in steels that are to be machined. When the chromium content reaches 2.00 per
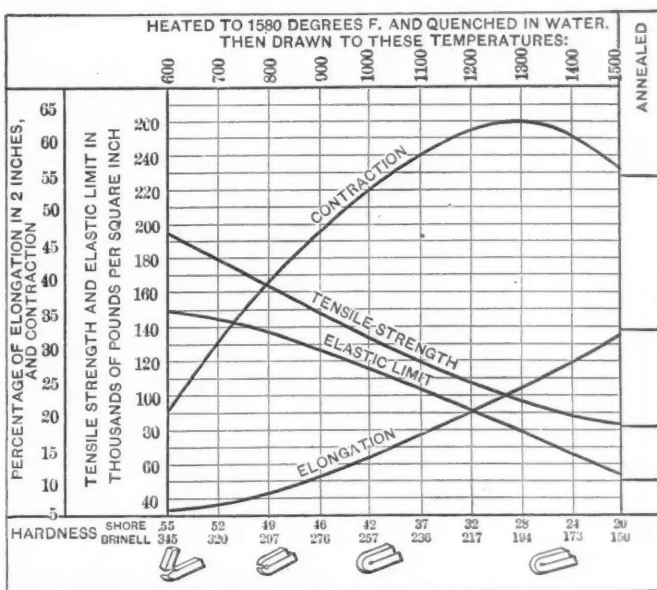
Fig. 2. Physical Properties of 0.20 Per Cent Carbon Natural Alloy Steel

cent, the steel is very difficult to cut when cold, and when higher percentages are used, the steel cannot be cut with any kind of cutting tools and must be ground to shape, this latter being an expensive method to pursue. Thus, in the high-grade nickel-chrome steels that are to be manufactured into parts of machines or instruments, the chromium is usually at or below 1.50 per cent. Owing to the difficulty of working even this steel, however, many grades of steel have been made with a chromium content of 0.25, 0.50 and 0.75 per cent, and it is for these grades that the natural alloy steel can be used.

In steel, the chromium gives the metal a hardness simi-

lar to that given by carbon, but to a lesser degree for the same percentage. It is a hardness, however, that makes the cohesion of the molecules much greater and thus greatly increases the static and dynamic properties. Chromium also greatly retards the formation of any grain or fiber, and thus makes the steel practically grainless. All of these effects of chromium upon steel cause it to increase its tensile strength, elastic limit, hardness, resistance to torsion, shocks, vibrations, or other stresses, and also increase its wearing qualities and prolong its life.

Influence of Nickel

Nickel increases the ductility, toughness and resiliency of steel, and also increases its susceptibility to heat-treatment. It reduces the size of the crystalline structure and microscopic cracks that are liable to develop into large cracks and produce ruptures. It was first added to steel to overcome the property of "sudden rupture" which is inherent in all carbon steels. It reduces the tendency of steels to become damaged by over-heating in hardening, and shows its effect in the hardening operations by making the tensile strength and elastic limit two and three times that of the un-treated, or annealed steel. Nickel raises the elastic ratio in steels, i. e., the elastic limit is raised to a higher percentage of the tensile strength. This condition is always sought for in the better grades of steel.

The tensile strength is rapidly increased with each increase in the percentage of nickel until a content of about 8 per cent has been reached. From that point to 15 per cent it makes the steel so brittle that it can be powdered under a hand-hammer, but after 15 per cent has been passed, the tensile

same temperatures as carbon steel; no special precautions are necessary. The high-grade nickel-chrome steel, however, must be heated to a white heat before being hammered, rolled, or drop-forged. The high temperature must also be maintained during this mechanical working, and if it falls very much, the steel must be reheated. Nickel steels must also be carefully handled when thus working them, and hence it will be seen that natural alloy steel is more cheaply worked into shape than other alloy steels. Natural alloy steel is similar to other alloy steels, however, in that it is very difficult to weld by ordinary methods; parts that are to be submitted to great strains should not be welded together. Like other alloy steels it can be welded with more or less success by the various electric welding processes and machines that are on the market. The electric machines that squeeze the parts together are preferable, as these prevent the grain from becoming coarse, as it does when other methods are used. If the steel is hammered after welding, this will aid in refining the grain that has become coarse at the weld. By careful workmanship with the electric process it is often possible to obtain from 70 to 80 per cent efficiency at the weld, whereas an efficiency of between 30 and 40 per cent is all that can be obtained by ordinary welding methods.

Natural alloy steels, like all other steels, will attain the highest strength only when properly heat-treated. In the untreated or annealed state, they show a tensile strength and elastic limit that is from 8000 to 10,000 pounds per square inch higher than carbon steels of the same carbon content, but when properly heat-treated they compare favorably with other alloy

TABLE II. EFFECT OF HEAT-TREATMENT ON FORGINGS OF NATURAL ALLOY STEELS

Per Cent of Carbon	Annealed				Heated to 1550° F. and Quenched in Water											
					Tempered at 1050° F.				Tempered at 1000° F.				Tempered at 600° F.			
	Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent	
	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction
0.30	89,500	57,500	28.0	51.9	106,500	76,000	21.0	51.9	131,000	114,000	17.5	51.9	193,000	177,000	8.5	30.7
0.40	88,500	56,000	29.0	51.9	112,500	83,000	23.0	59.8	130,500	118,500	18.5	51.9	209,000	188,000	10.5	37.1
0.50	119,500	68,000	18.0	37.1	135,000	107,000	16.5	46.2	155,000	138,500	14.0	43.0	252,000	232,000	7.0	24.0

strength returns, but not to quite as high a figure as is reached with an 8 per cent content. The elastic limit also continues to rise until 8 per cent has been reached and after the zone of brittleness has been passed, it again returns, but in a much smaller ratio than the tensile strength. From 20 per cent of nickel, upwards, the elastic limit cannot be made much greater than that of steels that do not contain nickel.

The elongation shows a slight rise until about 3 per cent of nickel is added to the steel, and after that it shows a rapid decrease, until the zone of brittleness is reached, when it becomes nil. With from 20 to 25 per cent nickel, the elongation again rapidly rises and from that point to 100 per cent it shows a slight increase. The best results, therefore, in steels that are used for machine parts, are obtained with a nickel content of 3½ per cent, although for some purposes 5 per cent nickel steel is used at a sacrifice of the elongation.

The two above elements in natural alloy steel, therefore, greatly enhances the value of this material for the various parts of machinery that are submitted to severe stresses. These steels also resist corrosion much better than other steels, the sulphuric acid test showing that they corrode from 10 to 20 per cent less than the low carbon and manganese, basic and open-hearth metals with nearly all of the impurities removed, and which have been given such names as "pure ingot iron," "old-fashioned iron," "toncan metal," etc. While there are some that doubt whether this test agrees with the actual weather conditions, it is generally conceded that steels containing nickel, corrode less rapidly than carbon steels and wrought iron.

Working Alloy Steels

Natural alloy steel can be hammered, rolled, drop-forged, pressed, stamped, or machined with the same ease and at the

steels. Some figures that were obtained from annealed and heat-treated forgings are given in Table II.

Heat-treatment

The heat-treatment is practically the same as that given other steels. The hardening temperature may vary somewhat, but not to any great extent. The brands containing from 0.15 to 0.20 per cent carbon should be heated to 1500 degrees F. and quenched in brine to obtain the best results. Those with a carbon content between 0.30 and 0.50 per cent should be heated to 1550 degrees F. They can then be quenched in water as readily as carbon steels, although oil and special liquid compositions can be used for the quenching bath with equally good results. The temperature at which they are afterwards drawn, of course, varies with the kind of work that the finished piece would be called upon to perform.

When hardening steel, a cold piece should never be put in a highly heated furnace, as it is liable to crack. It should either be preheated to above 600 degrees F., or it should be put in a cold furnace and heated up slowly. It should soak in the heat at the hardening temperature long enough for the piece to heat clear to its center. The work should never lie directly on the hearth of the furnace, but should be raised sufficiently to allow the heat to attack it from all sides, and it should be supported in a way that will not allow it to sag, as hot steel is soft and pliable and likely to bend. The axis of the piece should be vertical when plunging it into the quenching bath to prevent unequal contraction in cooling. The work should never have sharp grooves, corners, or other features, that easily develop cracks when the steel is heated and quenched.

In drawing steel, a furnace should never be used that is hotter than the drawing temperature. It is difficult to judge the temperature that the work has attained in such a furnace

and get within 50 degrees of the desired results. If the piece attains too high a temperature, it will be softer than that required, and if the drawing is too low, it will not be soft enough. With a tempering furnace held at the correct temperature, the work can be allowed to remain in it until it has absorbed the heat of the furnace and then accurate results can be obtained. A difference of 50 degrees in the drawing temperature is of much more importance than 50 degrees in the hardening temperature, and it is more difficult to estimate.

Casehardening

Carbonizing or casehardening can be performed in any of the various ways that are now used for other steels. Pieces can be heated to a red heat and quenched in cyanide to give them a depth of casehardened surface of a few hundredths of

Fig. 3. Physical Properties of 0.30 Per Cent Carbon Natural Alloy Steel

an inch; or they can be packed in iron boxes with bone and charcoal, or other carbonizing materials, and then heated in furnaces for a time that is sufficient to give them a greater depth of penetration. Where the output would warrant it, however, the special furnaces that have been designed for carbonizing with gas would probably give the most uniform results, if the work is properly done. This is also the cheaper method when large quantities are worked or handled.

In any case, however, the carbonizing mixtures should not contain over 15 per cent of moisture or 0.50 per cent sulphur. Moisture might cause a pitting of the steel which is liable to cause it to chip on the surface, while the sulphur soaks into the casehardened shell to a considerable extent. A carbonizing temperature of from 1750 to 1800 degrees F. can be used, and this will probably give the most rapid absorption and most uniform composition of the case. The time the steel is submitted to this temperature depends upon the depth of carbonized case desired.

After carbonizing, the work should be allowed to cool slowly until it becomes black in daylight. It should then be reheated to 1500 degrees F. and quenched in either oil or water. After this it should again be reheated to 1350 degrees F. and again quenched in either oil or water. This double quenching gives much better results on all steels than does the ordinary practice of quenching directly from the carbonizing furnace and reheating but once to about 1375 degrees F. and quenching in oil.

In casehardened work, the core of the piece has a carbon content of about 0.20 per cent while the carbonized shell contains about 1.00 per cent. Thus, there are two steels of a different nature and these should be given different heat-treatments. In the double quenching, the first heating and quenching hardens the core but overheats the case and makes it brittle. The second re-heating restores the case to its finest grain structure and also toughens the core, and the final quenching hardens the case.

Uses of Natural Alloy Steels

Natural alloy steels are largely used in the manufacture of automobile parts. A grade containing 0.15 per cent of carbon is often used for carbonized parts where the toughness of the core is of more importance than the strength or ability to resist shocks. When parts are required to withstand severe shocks or strains and have a good wearing surface, steel containing 0.20 per cent of carbon is used. This grade responds more readily to heat-treatment. Thus the change-speed gears, differential gears, drive gears, etc., are made from this steel. It is used without carbonizing where considerable toughness is required rather than strength, as in various structural parts. It is also used for cold rolling or cold pressing, and for such work as seamless tubes, small drop forgings, etc.

Tensile Strength, Elastic Limit, etc.

The tensile strength, elastic limit, elongation and contraction of this steel, as affected by various heat-treatment temperatures are shown in Fig. 2. The vertical lines show the drawing temperatures which are marked in degrees at the top, while the horizontal lines represent the tensile strength and elastic limit and the percentage of elongation and contraction. Below the chart are given the hardness scales of the steels, at these temperatures, taken from both the Shore and Brinell instruments. The cold-bend testing properties at the various temperatures are illustrated by the sketches below the chart.

From this diagram the heat-treatment that should be given this steel to obtain any of the properties that are within its range, can readily be ascertained. Thus if an elastic limit of 144,000 pounds per square inch, with a contraction of 31 per cent, is desired, the vertical line will show that the drawing temperature should be 700 degrees F. This would also give a tensile strength of about 177,000 pounds per square inch, and an elongation of about 6.5 per cent. The diagrams are based on 7/8-inch round stock; if larger pieces are used, the drawing temperature should be lowered.

The grade containing 0.25 per cent carbon is usually used for such parts as can be cold pressed, for instance, such parts as brake drums, frame members, axle housings, etc. These parts require all the strength that can be obtained in combination with enough toughness to withstand the operation of bending

Fig. 4. Physical Properties of 0.40 Per Cent Carbon Natural Alloy Steel

into shape without developing cracks or checks. Steel 1¼ inch round, of this grade, when made into bolts, has a tensile strength of 106,000 pounds per square inch, an elastic limit of 87,500 pounds, an elongation of 26 per cent, and a contraction of 69.5 per cent.

The grade containing 0.30 per cent carbon is still harder and more applicable to heat-treated parts. Hence it is made into axles, connecting-rods, jack-shafts, drive shafts, and other parts that require considerable strength and at the same time a high degree of toughness. It is also used for drop-forgings, heavy forgings and numerous other things. The strength, hardness and cold bending properties of the 0.30 per cent natural alloy steels are shown in Fig. 3. That still greater strength can be obtained than shown in this chart was proved by a test made by one of the automobile manufacturers. The test bar was

properly hardened and drawn at 600 degrees F.; the tensile strength was found to be 236,000 pounds per square inch, the elastic limit, 215,000 pounds, the elongation in two inches, 10.8 per cent, and the contraction, 36 per cent.

The grades containing 0.35 and 0.40 per cent carbon are usually used for spindles, rear axles, crankshafts, etc. From the 0.40 per cent grade are also made locomotive driving axles and heavy automobile truck axles, connecting-rods, piston-rods, steering knuckles, etc. The properties of the 0.40 per cent carbon grades are shown in Fig. 4. Some finished crankshafts, 2½ inches in diameter of the 0.35 per cent grade, had a tensile strength of 148,400 pounds per square inch, an elastic limit of 127,300 pounds, an elongation in two inches of 15.3 per cent, and a contraction of 53.8 per cent.

The 0.45 and 0.50 per cent carbon grades are used where extreme strength is needed in combination with considerable ductility. Thus, transmission gears that are to be heat-treated without carbonizing are usually made from this brand. The strength when heat-treated will, of course, be greater than shown in Fig. 4, but the ductility will be reduced.

At the present time there seems to be a tendency to "load" steels with alloying materials, and thus make them difficult to forge, weld, machine, or heat-treat; the results obtained do not always warrant the high prices of the finished parts. This natural alloy steel, however, is not overloaded with such alloying materials, but at the same time has properties that are well within the specifications for which many manufacturers are using much more expensive steels.

* * *

LIMITS FOR VARIOUS KINDS OF FITS*

The accompanying table gives the limits of accuracy used by the firm of Ludwig Loewe & Co., Berlin, Germany. The tabulated values are directly "translated" from the metric system, which accounts for the use of four decimal places in prac-

FOUNDRY AND MACHINE SHOP STATISTICS

The thirteenth census statistics of factories engaged in the manufacture of foundry and machine shop products are summarized in an advance bulletin issued by the director of the Bureau of the Census, Department of Commerce and Labor. These statistics show the number of establishments, the number of persons engaged, capitalization and value of the manufactured products. In the statistics are included all industries in the machinery field except those which manufacture distinctive products individually classified in the statistics, such as cash registers, calculating machines, sewing machines, and electrical machinery. The statistics are for the year 1909.

In this year there were 13,253 establishments, employing 615,485 persons, of which number 9851 were proprietors and firm members, 21,754 were salaried officers, superintendents, and managers, 42,242 were male, and 10,627 female, clerks; the average number of wage-earners was 521,011; the number of wage earners in the maximum month, December, being 597,234, and in the minimum month, January, 482,080. The total number of wage earners on December 15, 1909, or the nearest representative day, was 604,167, of which 587,636 were males and 11,895 were females, all 16 years of age and over; while 4093 were males and 543 females, under 16 years of age. The capital invested was $1,514,332,273. The total expenses were $1,077,736,456, of which $47,817,236 were paid officials, $45,977,781 clerks, $321,520,917 wage-earners, $23,750,838 fuel and rent of power, $516,260,301 other materials, $5,970,800 rent of factory or works, $6,269,172 taxes, including internal revenue, $6,653,816 contract work, and $103,515,297 other miscellaneous expenses. The value of products was $1,228,475,148. The value added by manufacture, which is the difference between value of products and cost of materials, was $688,464,009.

The states which lead in this industry are, in the order of their importance: Pennsylvania, New York, Ohio, Illinois,

ALLOWANCES FOR VARIOUS KINDS OF FITS

Diameter		$\frac{1}{4}-\frac{7}{16}$	$\frac{1}{2}-\frac{3}{4}$	$\frac{7}{8}-1\frac{1}{4}$	$1\frac{5}{16}-2$	$2\frac{1}{16}-3$	$3\frac{1}{2}-4\frac{1}{2}$	$4\frac{11}{2}-7$	$7\frac{1}{2}-10$
Hole	Min.	−0.0004	−0.0006	−0.0006	−0.0008	−0.0008	−0.001	−0.0012	−0.0015
	Max.	+0.0004	+0.0004	+0.0006	+0.0006	+0.0008	+0.0008	+0.001	+0.0012
Loose Fit A	Max.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
	Min.	−0.001	−0.0012	−0.0014	−0.0018	−0.002	−0.0024	−0.003	−0.0036
Loose Fit B	Max	−0.0008	−0.0012	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
	Min.	−0.0014	−0.002	−0.0024	−0.0028	−0.0032	−0.0038	−0.0044	−0.0052
Loose Fit C	Max.	−0.0012	−0.0014	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
	Min.	−0.002	−0.0028	−0.0032	−0.0037	−0.0044	−0.0052	−0.0064	−0.008
Sliding Fit	Max.	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0006	−0.0007
	Min.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
Drive Fit	Max.	+0.0004	+0.0004	+0.0004	+0.0004	+0.0003	+0.0002	+0.0002	+0.0002
	Min.	−0.0002	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0005
Press Fit	Max.	+0.0016	+0.0021	+0.0028	+0.0034	+0.0044	+0.0054	+0.0072	+0.010
	Min.	+0.0008	+0.0011	+0.0014	+0.0018	+0.0022	+0.0026	+0.0034	+0.0044
Shrinkage Fit	Max.	+0.001	+0.0014	+0.0018	+0.0024	+0.0032	+0.0044	+0.0058	+0.008
	Min.	+0.0006	+0.0008	+0.0008	+0.0012	+0.0014	+0.0018	+0.0036	+0.0052

(The rows Loose Fit A through Shrinkage Fit are under the side heading "Shaft".)

tically all instances. The table on which the one here published is based was published by *Verkstäderna* (Stockholm, Sweden). Only a few words are necessary to explain the use of the table.

It will be noted that three kinds of loose fits are specified. Loose fit A is for shafts resting in a single bearing; loose fit B for shafts resting in two or more bearings; and loose fit C for shafts with large clearance, lubricated with heavy lubricants, such as grease, etc. The sliding fit indicates a fit where the parts can be moved by hand, but without shake or play. The drive fit indicates a fit where it is necessary to assemble the parts with simple means, such as light blows or easy pressure. The press and shrinkage fits have their ordinary significance. By using this table, it is not necessary to put the limits on every dimension on the drawing, but simply to specify the kind of fit required.

Massachusetts, Connecticut, New Jersey, Wisconsin, Michigan, Indiana, Rhode Island, California, and Missouri. The average number of wage-earners employed in 1909, the total number of products, and the value added by manufacture (value of products less cost of materials) for these states, is tabulated in the accompanying table.

State	Average No. of Wage Earners	Value of Products	Value added by Manufacture
California	8,377	$26,730,891	$13,830,000
Connecticut	37,736	65,535,155	40,715,099
Illinois	52,266	138,578,993	74,768,805
Indiana	15,809	39,883,774	21,265,086
Massachusetts	44,179	86,925,671	55,743,781
Michigan	21,649	45,399,023	26,688,471
Missouri	7,443	19,975,149	10,819,432
New Jersey	27,815	65,398,437	35,458,387
New York	64,066	154,570,346	92,749,146
Ohio	64,817	145,836,648	81,276,753
Pennsylvania	86,821	210,746,257	109,735,517
Rhode Island	10,937	20,611,693	12,598,192
Wisconsin	24,219	54,124,000	31,590,264

* See MACHINERY, engineering edition, April, 1912: "Table of Allowances and Limits." See also MACHINERY'S Data Sheet Book No. 7, pages 26 to 31, inclusive: "Allowances and Tolerances for Various Kinds of Fits."

ANALYSIS AND HEAT TREATMENT OF LOW-CARBON AND ALLOY STEELS*

PRACTICE FOLLOWED BY THE FROST GEAR AND MACHINE CO., JACKSON, MICH.

By DOUGLAS T. HAMILTON†

The heat treatment of low-carbon steel differs considerably from that used for hardening ordinary tool or high-carbon steel. To begin with, low-carbon steel must be carburized, so that its outer surface will harden when the steel is again heated and dipped in oil. With tool steel it is only necessary to heat the steel to the desired temperature and plunge it in oil or water, after which the temper is usually drawn.

To obtain the best results when heat treating the modern alloy steels, the percentage of the constituent elements must

Fig. 1. Samples of Bar Steel and Milling Chips used in obtaining Chemical Analyses

be definitely known, and, therefore, a sample of each bar of steel should be analyzed before any parts are made from it. The greatest difficulty encountered in heat treating alloy steel is that if the carbon content varies but a few points, unsatisfactory results will be obtained unless this variation is taken into account. This is particularly true in heat treating drop forgings for automobile gears, which are subjected to heavy duty. The very best steel obtainable is of little value unless properly heat treated. The annealing, harden-
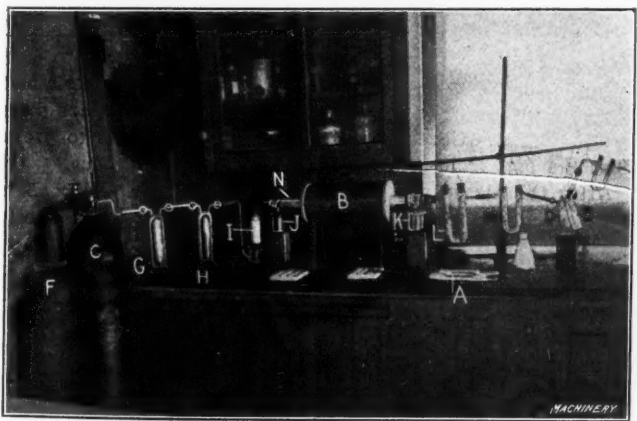
Fig. 2. Electric Furnace and Combustion Train used in determining Carbon Content of Milling Chips from Sample of Bar Steel

ing and tempering must be attended to with great care and thoroughness. Drop forgings are more difficult to heat treat properly than parts made from bar stock.

In no branch of the metal working industry is greater care given to the heat treatment of steel than in automobile manufacture. This industry has practically revolutionized former methods of making and heat treating alloy steel. In the following article a description is given of the heat treating methods employed by the Frost Gear & Machine Co., Jackson, Mich., which firm makes a large number of gears for the automobile trade. After having had considerable difficulty in heat treating automobile parts, owing to the

variations in the carbon contents, and often to variations in the entire chemical composition, this firm installed a chemical laboratory in connection with its hardening department. Now, before any material is made up into gears or other parts, it is analyzed and its chemical composition ascertained.

In order that a manufacturer may be able to guarantee that all parts turned out by him are up to a certain standard, it is absolutely necessary that he follow some definite plan of analyzing and heat treating the different grades of steel. It is not wise to rely solely upon the steel mills for the correct analysis, for the simple reason that it is difficult to keep defective material from getting mixed up with the good stock. This is not always due to negligence on the part of the steel mill, but sometimes happens during transportation, unloading, etc.

Grading and Analyzing Steel

In ordering steel, the Frost Gear & Machine Co. gives the steel mill a complete analysis of the steel required. When the steel is received the bars are painted according to a certain standard. For gear stock the following colors are used to designate the different grades of steel:

Grade of Steel	Color
3.5 per cent nickel................	Lemon yellow
0.15-0.20 per cent carbon, open-hearth machine steel	Pale green
0.30-0.40 per cent carbon, open-hearth	Medium green
0.40-0.50 per cent carbon, open-hearth	Dark green
Chrome-nickel steel	Deep red
Vanadium steel	Black

Fig. 3. Record of Analysis of a 3 1-2 per cent Nickel Halcomb Electric Annealed Alloy Steel—Actual Size of Record Sheet, 9 by 7 3-4 inches

A wide stripe denoting the character of the steel is painted longitudinally on the bar, and a narrow diagonal stripe, of a different color, is used to designate the steel maker's name.

There are at the present time three common methods for determining the carbon contents of steel. The first and possibly the most common method is the use of the electric furnace and combustion train; the second is microscopic analysis; and the third, color comparison.

To obtain the carbon contents by means of the electric furnace and combustion train, a sample must be cut from each bar and chips obtained from these samples by milling or drilling. Milling chips are to be preferred, as these can be obtained quickly and can be taken from the entire cross-section. In milling off the chips, no oil should be used on the cutter, because a drop of oil in the chips would raise the carbon content far above its true percentage, due to the fact that oil is composed largely of carbon.

These chips are placed in small bottles labeled as shown in Fig. 1, the labels carrying the serial invoice number and the number of the bar. For example, suppose twenty-two bars of a certain brand of steel have been ordered, and that the serial invoice number is 130; then the first bottle, containing the chips from bar No. 1, would be labeled $\frac{130}{1}$, and the following bars and bottles would be marked consecutively

$\dfrac{130}{2}$, up to and including $\dfrac{130}{22}$. The sample from which the chips are taken is also marked, and kept on the shelf with the bottles, as shown in Fig. 1. A sheet, as shown in Fig. 3, is made out for each bar of which an analysis is made, and this is filed away for future reference.

Obtaining the Carbon Contents by Means of the Electric Furnace and Combustion Train

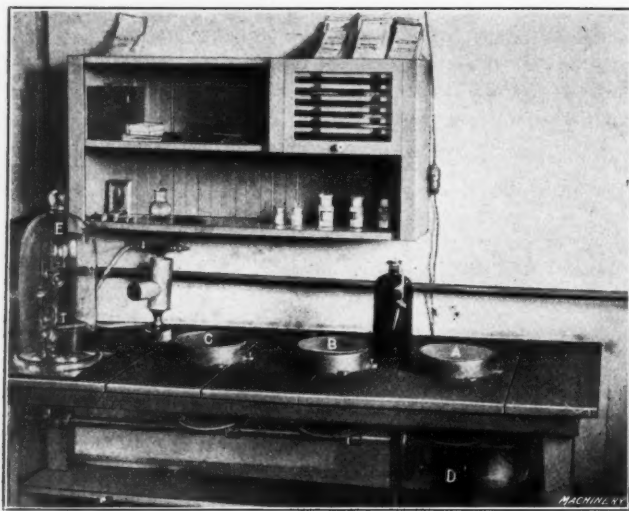The distinctive features of the different grades of steel are due more to variations in the carbon contents than to varia-

Fig. 4. Polishing Disks for Polishing the Specimen of Steel and Microscope used for Determining Structure of Steel

tions of any of the other elements, so that the carbon analysis is really the most important point to consider. A very small percentage of carbon makes a considerable difference in the quality of the steel after hardening.

To obtain the carbon analysis by the electric furnace and combustion train, the milling chips are put in a small alundum boat A, containing aluminum oxide, as shown in Fig. 2. The latter is placed in the electric furnace B, where the chips are heated to about 1800 degrees F. A stream of oxygen from tank C is passed over the chips until the carbon has been burned out, the resulting gas—carbon dioxide (CO_2) —being collected in a liquid, potassium hydrate, in the

Fig. 5. Two of the Casehardening Furnaces

potash bulb D. Now, after all of the carbon has been burned out of the milling chips, the weight of bulb D is compared with that of counterpoise bulb E, and its gain in weight noted; before burning out the carbon of the chips the difference in weight between bulbs E and D was ascertained. By a simple calculation, taking into account the weight of the milling chips, which have also been weighed before being put into the furnace, the percentage of carbon in the steel is obtained.

The names of the various tubes and devices used in connection with the electric furnace and combustion train shown in Fig. 2, starting at the left, are as follows: F, extra oxygen tank; C, oxygen tank; G, concentrated potassium hydrate bulb; H, concentrated sulphuric acid bulb (these two bulbs are called gas washers and act as the purifying train for the oxygen); I, granulated calcium chloride tower; J, cooling wick

for the terminal of the quartz combustion tube; N, quartz combustion tube; B, electric furnace; K, another cooling wick; L, a U-tube containing granulated zinc; and M a U-tube containing calcium chloride. U-tubes L and M comprise the purifying train for the carbon dioxide collected from the milling chips being heated in the electric furnace. Finally, D is the weighed potash bulb and E the counterpoise bulb.

Analyzing Steel by Microscopic Inspection and Chemical Analysis

The microscopic examination of steel is of the utmost importance, as it reveals the nature of the metal to such an extent that the knowledge obtained thereby can be used to good advantage for practical purposes. Some of the problems which previously were beyond the scope of chemical analysis have been elucidated by means of the microscope. Of course, to use a microscope to the best advantage, it is necessary that the characteristics of steel and their relation to the appearance of a section when greatly enlarged, be understood.

To prepare the steel for microscopic examination, a small piece of the required size is cut from the bar and then ground as smooth as possible. After this, it is polished by means of different abrasive materials on the small polishing stands shown in Fig. 4. The first stand A consists of a disk covered with canvas and charged with fine alundum. The disk on stand B is covered with ordinary pocket lining, and is charged with lenigated alumina, while the disk on stand C is covered with broadcloth and charged with rouge. These polishing stands are driven from a shaft located beneath
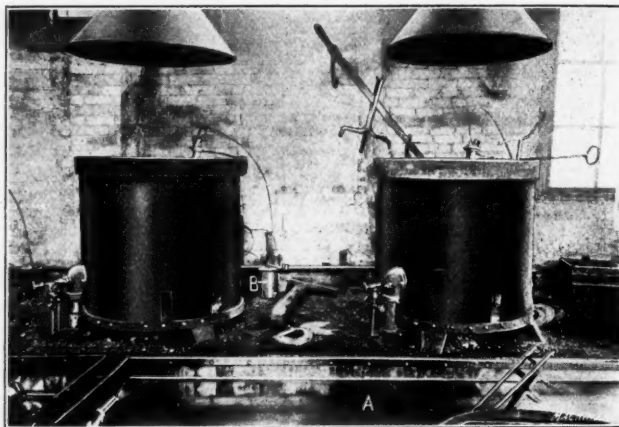
Fig. 6. The Lead Baths used for Heat-treating the Parts

the bench, which, in turn, is operated by a small electric motor D. The disks are used in the order in which they are placed, starting at A. Covers are placed over these disks to prevent dust and dirt from collecting on the abrading surface.

After the piece to be examined under the microscope E has been polished to a high degree, it is etched with a five per cent solution of picric acid, in alcohol for annealed steels. This brings the structure of the steel into prominence, the less readily attacked constituents being left standing in slight relief, and the structure thus rendered visible. One of the most striking objects which appears under the microscopic treatment, sometimes causing a beautiful play of colors, is pearlite, which has a pearly lustre, from which it derives its name. Pearlite is an intimate mixture of ferrite and cementite and consists of 87 per cent of ferrite and 13 per cent of cementite. Lamellar pearlite, which was clearly defined in the analysis recorded in Fig. 3, is a formation which consists of alternate plates of ferrite (pure iron) and cementite (carbon of iron Fe_3C). The ferrite is readily attacked by the etching acid, leaving the cementite standing out in relief.

The other constituents in the steel, such as nickel, manganese, sulphur, etc., are generally obtained by chemical analysis. This method can only be carried on successfully by an experienced metallurgist, as the determination of the percentage of any one constituent usually is obtained by volumetric titration with standard solutions of reagents.

Carburizing

When the material has passed analysis and is found to be "O. K.," the blueprint number of the piece for which this grade of steel is to be used is painted on the end of each bar.

This gives the foreman authority to use it. Any bars found to be of wrong chemical composition or difficult to machine, or that do not show up properly under microscopic inspection—showing slag and defects—are picked out and returned to the mill. After the part is made that is to be carburized, it is painted with fire clay where a hardened surface is not required, and then put in a carburizing compound, composed

Fig. 7. Hoskins Electric Pyrometer used for Regulating the Temperature of Casehardening, Heat-treating and Tempering Furnaces

of charred leather, crushed charcoal and ammonium carbonate.

The work is packed in pots in this mixture, the lids put on and sealed with fire clay, and then the pots are put in the carburizing furnaces, two of which are shown in Fig. 5. The temperature in these furnaces is raised to the desired point and maintained for a sufficient length of time to let the carbon penetrate into the steel about 0.02-0.04 inch. This generally requires from three to five hours after the correct temperature has been reached. Of course, the length of time depends entirely upon the depth of casehardening desired and the size of the piece to be treated. The temperature in the pot is slightly greater than that near the walls of the furnace, and is consequently greater than that registered on the pyrometer.

The carburizing furnaces are heated by high-pressure fuel oil burners having a pressure of 18 pounds on the oil and 40 pounds on the air for atomizing, and about 12 ounces for supplying air for combustion through a two-inch pipe. The temperature is recorded on a Hoskins electric pyrometer, Fig. 7, which is provided with "reading contact points" for all the furnaces in the room. After the parts have been left in the furnace for a sufficient length of time, the pots are taken out of the furnaces and allowed to cool down gradually, the covers not being removed until the pots are perfectly cold; then the covers are taken off and the parts unpacked and heated to treat the core, and plunged in oil; they are then again heated to from about 1350 to 1425 degrees F., to harden the case, dipped in oil, and tempered.

Heat-treating Automobile Drive Gears

Automobile drive gears which contain 3½ per cent nickel, are put in a lead bath after carburizing (see Fig. 6), and are heated from 1550 to 1600 degrees F. After the gear is brought to this temperature it is taken out and quenched in the bath of running oil shown at A. Fig. 6. Charcoal is put on top of the lead to prevent it from oxidizing. This also helps to keep the temperature even and prevents the lead from sticking to the gear. After quenching, the gear is again heated to a temperature of from 1325 to 1350 degrees F., so as to

harden the case. After the gear is brought to the proper temperature, it is quenched in the running oil bath.

Tempering

Most automobile gears and other parts require to be tempered after being heat treated. The tempering is accomplished in an oil bath shown in Fig. 8. The work is placed in the basket shown and the latter lowered into the oil, which is a grade of fish oil, called "No. 14 tempering oil." This is heated to from 325 to 400 degrees F. for nickel steel, and from 550 to 600 degrees F. for oil-hardening chrome-nickel steel. After the work has been brought to the same temperature as the bath, it is allowed to remain for a certain specified time, and is then removed and allowed to cool off gradually. It is then washed in a lye solution and sand blasted.

All of the oil tempering, casehardening and heat treating furnaces are supplied with the same type of oil pressure burners. The cold ends of the thermo couples are surrounded by water jackets in which cool water is circulated as indicated at B in Fig. 6. This water jacket keeps the couples at an exact temperature and thus makes possible correct reading on the pyrometer. The pyrometer is tested from time to time and is automatically regulated according to the temperature of the room.

Examining the Fracture of a Broken Gear

After a sample is carried through in the manner previously described, it is broken with a sledge hammer to determine if the core has been heat treated properly, or whether crystallization has taken place. This process of breaking and examining is carried on until a piece is obtained which shows that it has been properly heat treated. The operations are slightly varied until a satisfactory final result is obtained.

Fig. 9 shows a drive pinion for an automobile, which has been broken to show the fracture. This pinion was made from a drop forging as is clearly indicated in the illustration, where the grain of the steel is seen to follow closely
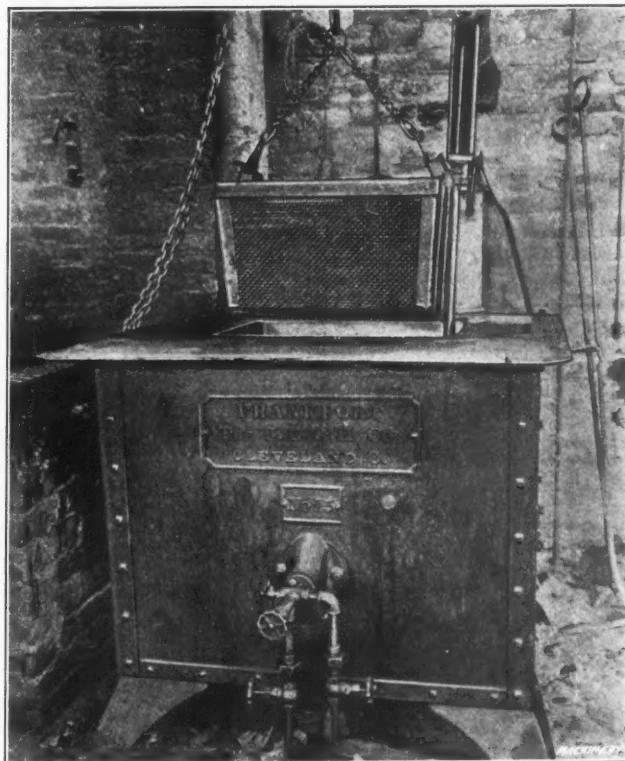

Fig. 8. Oil Bath for Drawing the Temper after Hardening

the shape of the gear. The depth of the case also stands out very prominently. At B are shown cracks which illustrate that the case, which is extremely hard, cracked when breaking the gear, but the core still remained intact. A tooth broken off by the sledge is shown at C.

The scleroscope is used to determine the hardness of a gear after being heat treated, but it is not relied upon altogether. Sometimes a gear can be "touched" with a file after a high reading has been obtained by the scleroscope. The

main point in heat treating steel is to get a close-grained and "velvety" structure. If the structure is coarse, the part will not be strong and will be easily broken. After a piece has been carried through the process previously outlined, broken and found to be all that is desired, all parts made from the bars containing the same percentages of the various ingredients are given the same treatment. The data thus collected, are tabulated, and filed away for future reference, as shown on the chart in Fig. 3.

Heat-treating a Main Drive or Ring Gear for an Automobile

The main drive or ring gear used on an automobile is considered by most automobile manufacturers as one of the
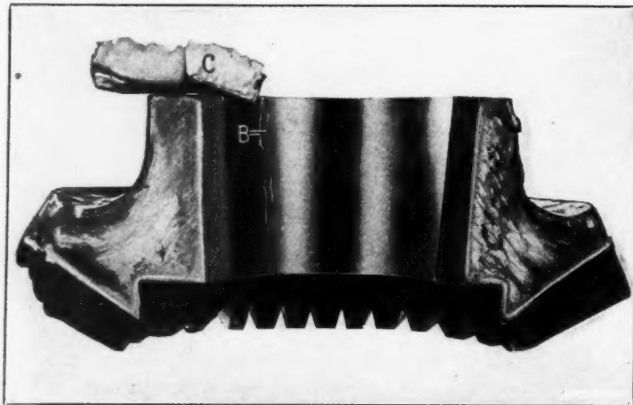
Fig. 9. An Automobile Drive Pinion broken to show Structure of Steel after Heat-treating

most difficult parts to make, and more money is being spent on perfecting this one gear than on any other part. It is very difficult to turn out a gear which has not been slightly distorted during the heat treating operations; such gears will produce considerable noise when running at a high speed. This is a very objectionable feature, and every possible means is devised and employed to obviate it.

The gear shown in Fig. 10 is made from 3½ per cent nickel steel, containing 0.18 per cent carbon. The blank is cut from flat stock of oblong section, split in the center and then expanded to form a ring. This ring is then heated and finished to the desired shape by drop forging. It is evident
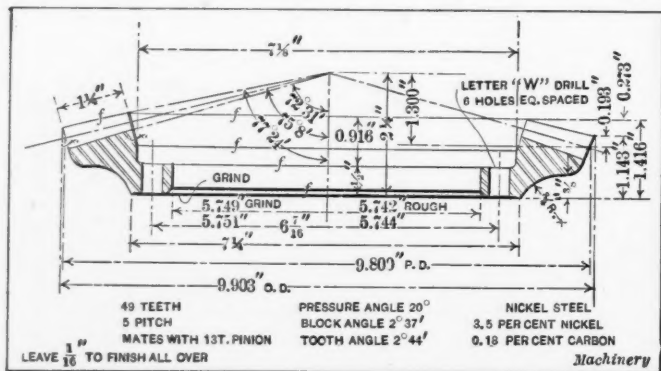
Fig. 10. Automobile Main Drive or Ring Gear to be heat-treated

that the grain of the steel will practically form a complete circle when worked in this way, and this tends to prevent the finished piece from distorting much during the heat treatment. After being drop-forged, the gear is annealed and allowed to cool off gradually; then it is sent to the machining department where it is machined to the correct shape, the teeth cut and all the operations, except grinding, performed. It is then painted on the back with fire clay, put in the carburizing furnaces, and passed through the operations previously outlined.

The heat treatment for this particular gear was as follows: Heated in carburizing compound for four hours at a temperature of 1650 degrees F. and allowed to cool off in the pots; then heated in lead pot to a temperature of 1580 degrees F. and quenched in oil; heated in lead to 1325 degrees F. and quenched in oil; after this, allowed to remain in the oil tempering furnace for one hour at a temperature of 375 degrees F., taken out, allowed to cool off gradually, washed and sand blasted.

It has been found from actual experience that the best way to determine the proper heat treatment for any particular grade of steel or parts made from it is to put a sample through the regular heat treating process, break it and examine the structure. By following this method and using the tabulated data obtained when making the analysis as a guide, very satisfactory results are secured without recourse to any "rule of thumb" methods.

In closing, the writer wishes to express his appreciation of the assistance given him in the preparation of this article by Mr. E. J. Frost, president of the Frost Gear & Machine Co.

* * *

CUTTING AN OIL GROOVE IN A BORING MILL

A simple but rapid method of producing a zig-zag oil groove in a circular piece of work is shown in the accompanying illustration. The work is a 10-foot table for a Cincinnati boring mill, and the machine in which this unusual feat is being accomplished is a Cincinnati 10–16-foot boring mill. The oil groove is 1/4 inch wide and about 3/32 inch deep, and is completed in one minute—the time required for the table to make one revolution. The zig-zag path of the groove is the result of the combined movements of the work and tool-head.

In action, the operator after setting the tool and feeding it down to the proper depth, grasps the shifting lever for operat-
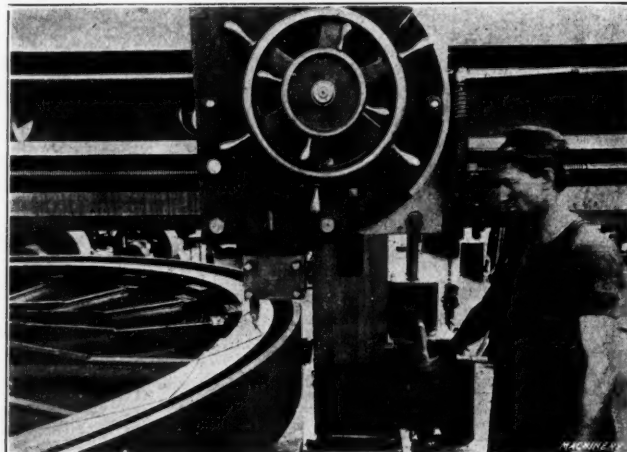
Set-up and Method of Cutting an Oil Groove 1-4 inch wide by 3-32 inch deep, and over 32 feet long in One Minute on a Cincinnati 10-16-foot Boring Mill

ing the rapid power traverse of the tool-head (as shown in the illustration), and then starts up the machine. He watches the cutting tool closely, and as it approaches the edge of the circular bearing, shifts the lever to traverse the tool-head in the opposite direction. This procedure is followed until the table has made one complete revolution, when the oil groove is completed. Formerly this oil groove was laid out, and then chipped with a chisel and hammer, the time required being about six hours.

The cutting of this oil groove in the manner described, illustrates the ease of control of the boring mills manufactured by the Cincinnati Planer Co., Cincinnati, Ohio.   D. T. H.

* * *

THE BEGINNINGS OF MONEL METAL

About seven years ago one of the large smelting companies began investigating the chemical and physical properties of an alloy that had been reduced directly from a nickel-copper matte without the previous separation of the two metals. This alloy was found to possess not only the valuable properties of nickel, but also other desirable properties in addition, that would insure a wide usefulness, and owing to the simple method of production, was obtainable at about one-third the cost of nickel. In 1905-6 the International Nickel Co. considering, no doubt, that for many purposes there was no need to separate the amicable metals nickel and copper, took up the problem of reducing them together and obtaining an alloy of the two metals in the proportions in which they occur in the ore. The alloy thus obtained was named Monel metal, after Mr. Ambrose Monel, the president of the International Nickel Co.

BOSTON GEAR WORKS NEW FACTORY

LAY-OUT AND MACHINE EQUIPMENT

Of the few large plants in the United States devoted exclusively to the manufacture of gears the Boston Gear Works probably is the largest manufacturing such a great variety of gears. This firm started business in Boston in May, 1891, with twelve men, under the management of Mr. Frank Burgess. The business gradually grew so that during the spring of 1906 an enlargement became necessary, and a modern one-story factory of saw-tooth construction, with the exception of the office department, was built at Norfolk Downs, about six miles from Boston. This plant was completely destroyed by fire November 27, 1909.* In less than one week after this fire, gears were cut in a nearby building on machinery taken from the ruins.

By February 10, 1910, a new and better factory was completed on the site of the old structure, and running on full time. This record was due to the great energy of Mr. Burgess, and the cooperation of his 125 employes.

Fig. 1. Plan of Boston Gear Works

The new factory, like the old, is of saw-tooth roof construction, which had proved very satisfactory. The office is placed on the first floor in order to give more uniform light and direct communication with the factory. There is 29,000 square feet of floor space in the main building, and a total floor space, including other buildings, of 37,000 square feet.

The main building is divided into two parts by a fire wall,

wright and experimental rooms, a steam heating plant, and one 50 H. P. De LaVergne oil engine, and in the basement under part of the main factory building are located a 50 H. P. De LaVergne oil engine generator, pumps, etc., several cutting-off machines, and steel racks. In 1910 a power plant was erected in a new building 31 feet by 32 feet, adjacent to the fire wall of the main factory building, and an 85 H. P. Hornsby-Akroyd-De LaVergne oil engine installed.

The main factory is divided into about fourteen separate departments, each under a working foreman, scientifically arranged so that the work may progress in the most systematic manner. The entire equipment consists of about 225 machines, seventy-five of which are automatics, most of them being of the latest design. The equipment by departments is as follows:

The model, or small gear department, consists of over forty turning and gear cutting machines, ten of which are automatics. Most of these machines were designed and built by the Boston Gear Works. The Cleveland automatic section consists of seven Cleveland automatic turning machines, handling bar stock up to six inches diameter. This department also includes four Acme and two Hartford automatic screw machines. The Potter & Johnston section contains three Potter & Johnston automatic chucking machines, one plain chucking machine, one Jones & Lamson, one Prentice, one Bullard and two Fay lathes. The Gleason gear planing section consists of six bevel gear generators and three single tool
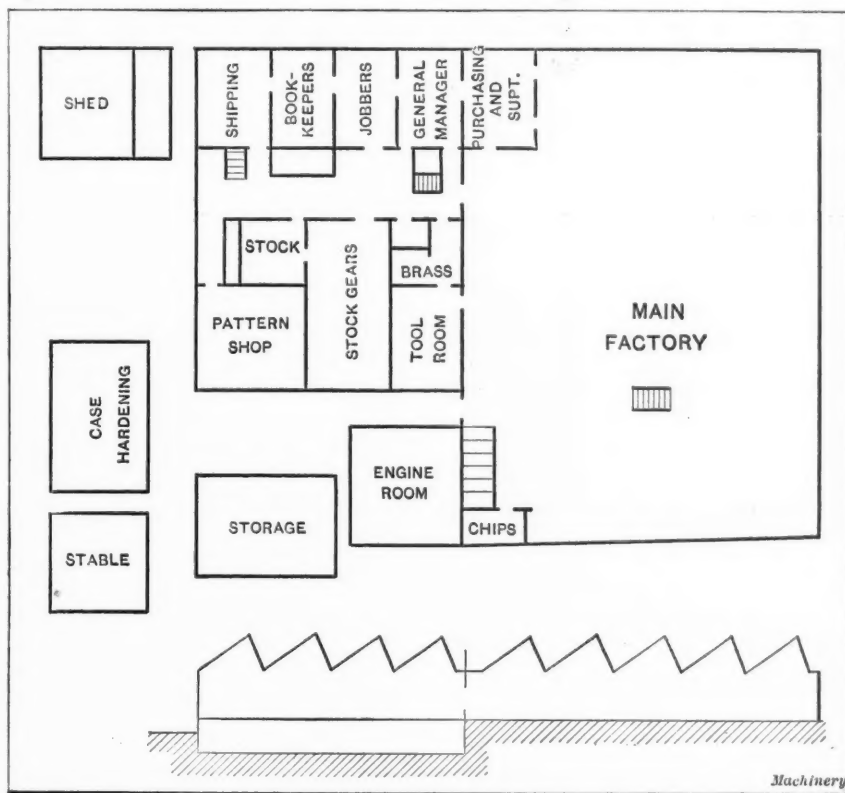
Fig. 2. General View of Boston Gear Works
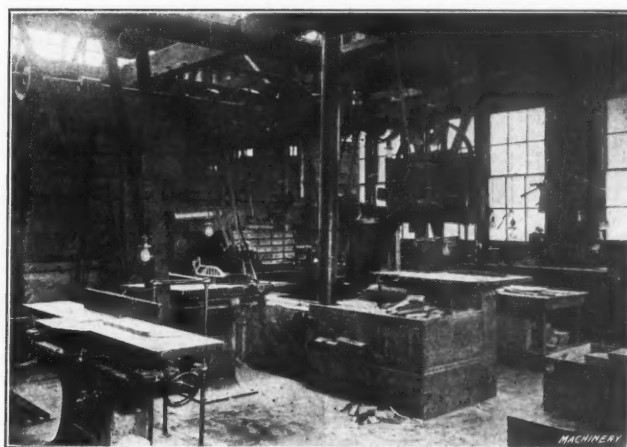
Fig. 3. The Pattern Shop

the factory section being 90 feet by 131 feet, and the office section 90 feet by 71 feet. In the office section are located the pattern shop, two gear stockrooms, toolroom, shipping room, and three offices, on the ground floor. The three offices, being those of the general manager, bookkeepers and jobbers, are so arranged that quick communication can be had with each other, as well as with the main factory section.

In the basement under the office section are storage, mill-

* See "New Plant of the Boston Gear Works," November, 1906, for description of the plant destroyed by fire.

planers, taking in work up to forty-eight inches diameter. The Whiton section comprises nine automatic milling machines for cutting sprockets, spur and bevel gears of small diameters. The spiral section contains ten machines for cutting spiral and worm gears up to thirty-six inches diameter. The hobbing department includes seven machines for cutting spur, helical and worm gears, up to ten feet in diameter. The Fellows and Gould & Eberhardt department consists of six Fellows gear shapers, including one rack cutter; seven Gould & Eberhardt automatic spur and sprocket gear cutters, and
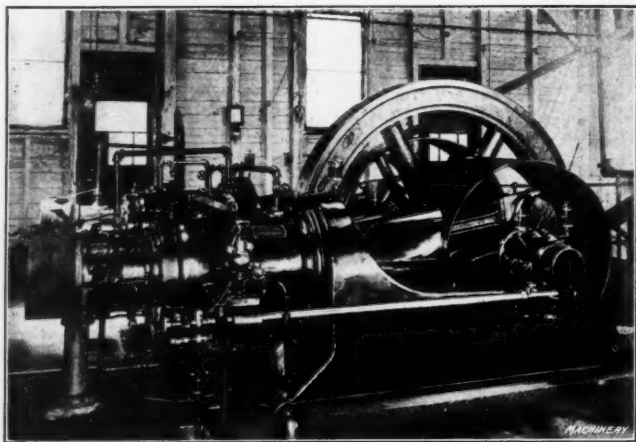
Fig. 4. Eighty-five H.P. Hornsby-Akroyd Oil Engine Power Plant

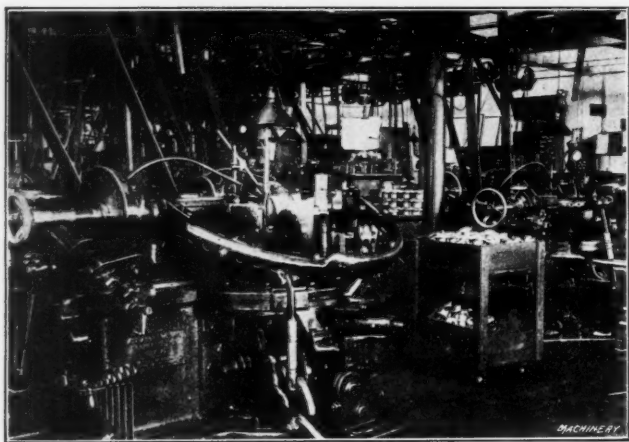
Fig. 5. Cleveland Automatic Department
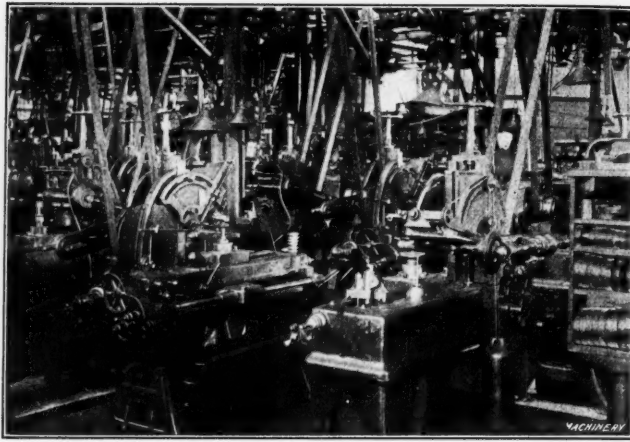

Fig. 6. Gleason Gear Planing Department

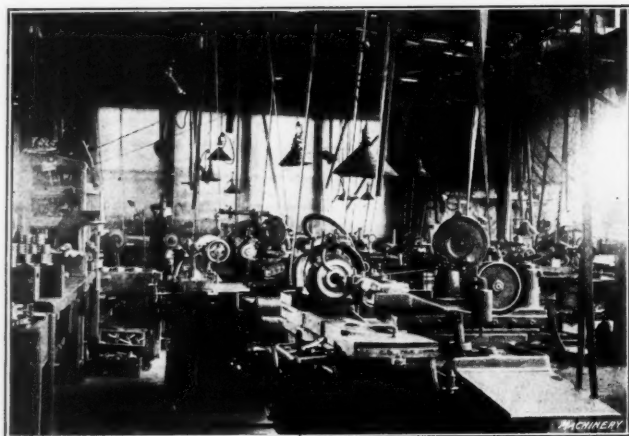Fig. 7. Whiton Gear Cutting Machine Department
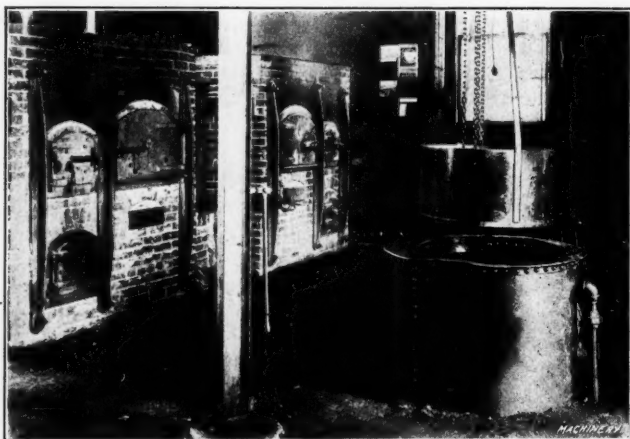

Fig. 8. Grinding Department
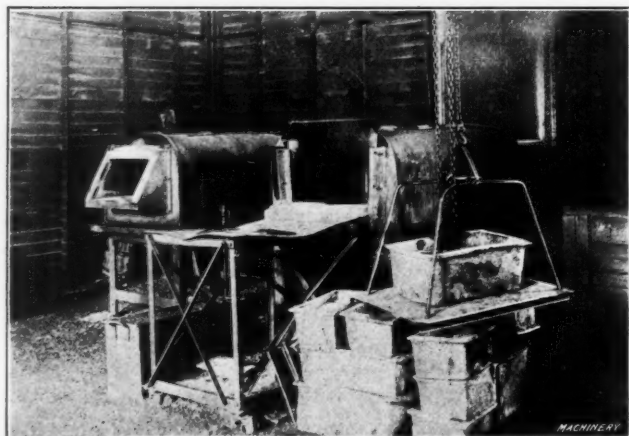

Fig. 9. Coal Carbonizing Furnaces

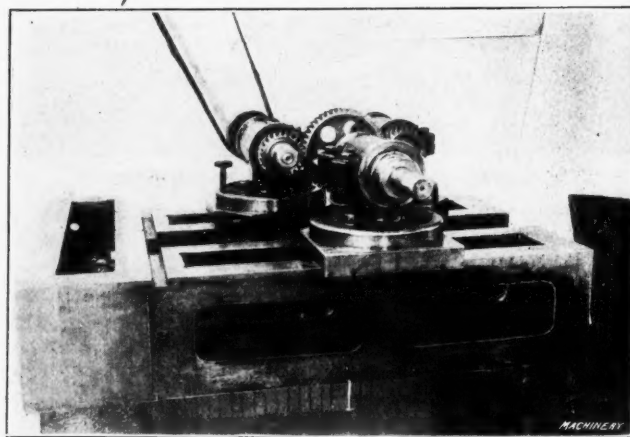Fig. 10. American Gas Furnaces equipped for burning Oil

Fig. 11. Universal Gear Testing Machine

one Brainard machine. Gears up to seventy-four inches diameter can be cut in this section. The lathe, drill and miscellaneous department contains twenty-two machines. The tool section consists of twelve machines, among which are milling and special hobbing machines. The grinding department comprises nine universal, plain and internal grinding machines.

In 1911 a new casehardening plant, 26 by 45 feet, of fire-proof construction was built, consisting of a steel frame covered with asbestos protected metal. This plant is equipped with two modern brick coal carbonizing furnaces, two of the American Gas Co.'s furnaces equipped for burning fuel oil,

IRON AND STEEL INDUSTRIES IN U. S.

The director of the Bureau of the Census, Department of Commerce and Labor, has issued an advance bulletin giving a summary of the thirteenth census statistics with relation to the number of establishments, persons engaged and capital invested in the steel works and rolling mill industry in the United States. This industry, considering the value of the products, ranked fourth among the industries of the country in 1909.

In that year there were 446 establishments with a total number of 260,762 persons engaged, of which 47 were proprietors and firm members, 4239 salaried officers, superintendents and

Fig. 12. Bevel Gear Testing Machine
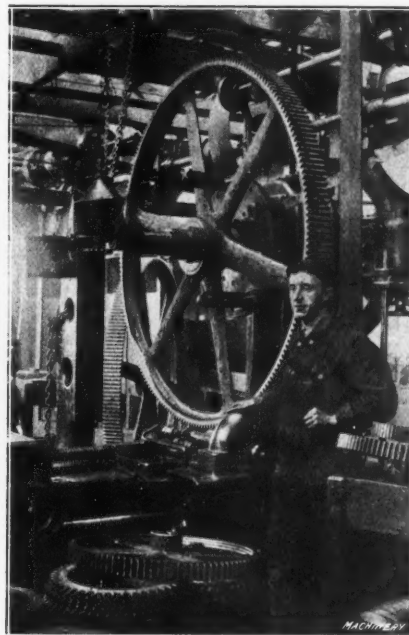
Fig. 13. Gould & Eberhardt Department
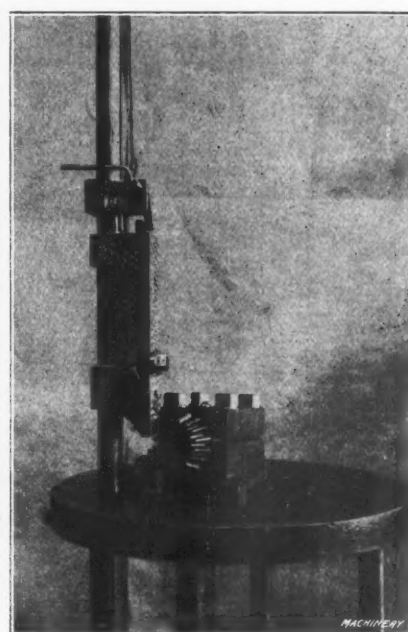
Fig. 14. Drop Hammer Testing Machine

and lead reheating and oil tempering furnaces, also using fuel oil. The temperatures are recorded by a Bristol pyrometer, and the very latest and best methods are used for treating all kinds of steel.

The inspection department is equipped with the latest and best machines for testing gears under actual running conditions; there are also all kinds of measuring tools, such as plugs, micrometers and tooth vernier calipers, drop hammer machine and scleroscope for testing heat-treated gears. Back of all this

managers, 14,613 male, and 1767 female, clerks. The average number of wage-earners was 240,076; the number in the maximum month, December, was 283,629, and in the minimum month, March, 215,076. The primary horsepower was 2,100,978. The capital invested was $1,004,735,111. The total expenses were $889,501,220. The value of products was $985,722,534. The value added by manufacture, which is the difference between cost of materials and value of products, was $328,221,678.
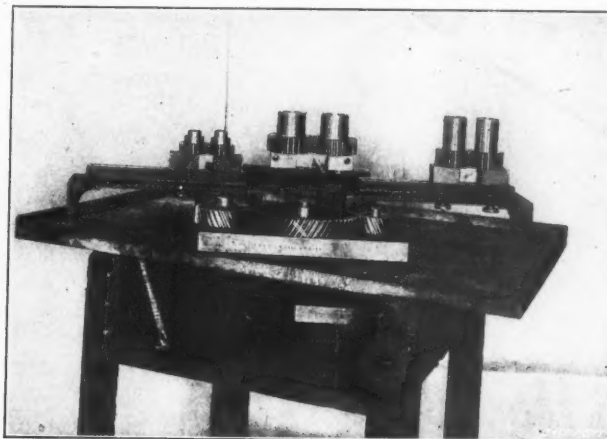
With regard to the number of wage-earners employed, the

Fig. 15. Inspection Department

Fig. 16. Spur and Spiral Gear Testing Apparatus

equipment is thirty-two years experience in the manufacture of all kinds of gears.

The works are prepared to handle large or small quantities of special gears from one-eighth inch to ten feet diameter. They make a specialty of all kinds of steel gears, including automatic differential and transmission gears, as well as fan, cam, timer, and pump gears for engines. Recently a number of worm and helical gear cutting machines were developed to manufacture special worm gear combinations both small and large to transmit light and heavy power. They will also soon be prepared to manufacture in large quantities worm gears for automobile rear axle drives, both of the straight and Hindley types.

leading states in the order of their importance were as follows: Pennsylvania, Ohio, Illinois, Indiana, New York, West Virginia, New Jersey, and Massachusetts. The accompanying table gives the average number of wage-earners, the value of the products, and the value added by manufacture in these states.

States	Average No. of Wage Earners	Value of Products	Value added by Manufacture
Illinois	17,584	$86,608,137	$30,363,674
Indiana	12,255	38,651,848	12,553,089
Massachusetts	3,115	13,567,628	3,535,355
New Jersey	4,671	12,013,719	5,378,679
New York	10,091	39,532,414	13,643,244
Ohio	38,586	197,780,043	58,536,888
Pennsylvania	126,911	500,343,995	171,330,574
West Virginia	5,060	22,435,411	6,539,111

LETTERS ON PRACTICAL SUBJECTS

GRINDING GAGES WITH SPHERICAL ENDS

A number of spherical end gages, from 2½ to 6 inches long, were to be made, and the device shown in the accompanying engraving was designed for grinding them so that they would be of the correct length when measured anywhere over the ends. This device can be used on any grinding machine having ordinary centers. The illustration practically explains itself. One end of bar *A* is turned down to suit the ordinary driving dog. The other end is turned down for a spring and provided with a stop-collar. The central portion is bored and ground to fit the swiveling plug *B*, and
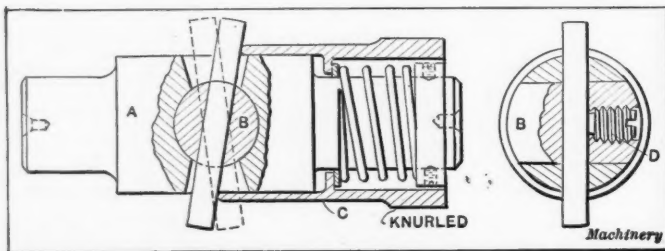
Device for Grinding Gages with Spherical Ends

has a slot cut through it at right angles to the plug. This slot should be of the same width as the diameter of the gage to be ground. The swiveling plug is drilled and reamed to fit the gage and provided with a clamping screw *D*.

A piece of round steel of the same diameter as the gage to be ground and with a length equal to the diameter of the bar *A*, is inserted through the slot and clamped in the swiveling plug. The outside of the bar and the ends of the plug are now ground up together to suit the bore of sleeve *C*. This sleeve keeps the plug in position when the gage is removed, and, being provided with a cam surface on its end, gives the required motion to the gage being ground. The right-hand end of this sleeve is knurled so that the operator can grip it and hold it stationary while the remainder of the device rotates.

The gages to be made are rough-turned, cut off to the required length with proper allowances, and the diameter ground to suit the slot and the bore of the swivel. Then the centers are removed and the gage inserted in the fixture and clamped central by screw *D*, and finish-ground on the ends. Only a slight grip on the sleeve is required to hold it stationary, so that the gage to be ground will swivel to and fro against the cam surface on the end of the sleeve.

G. R.

SEASONING CAST IRON

In the June number of MACHINERY, R. L. S. asks for some method for quickly seasoning castings. The writer would advise him that the quickest way of removing the internal strains is to anneal the castings, provided facilities for this process are at hand. Mr. George M. Bond of Hartford, Conn., whose work in connection with accurate measuring machines is well known, first has the beds of the machines rough-planed and then anneals them in the Jones process furnace. In this furnace, which is the invention of Mr. H. K. Jones of Hartford, Conn., the work to be annealed is kept in a closed receptacle. This prevents oxidation and the work will come out as bright as it goes in.

The measuring machine beds mentioned are of box section about three feet long; 1/16 inch is allowed for the finishing cut after annealing. The planing is practically all on one side and none of the castings have warped in the annealing process to such an extent that they would not finish up properly in the subsequent replaning; *i. e.*, they have sprung much less than 1/16 inch.

The special skill in connection with annealing lies in choosing proper points for supporting the casting and heating it to a low red heat only. It has not been found necessary

to run the heat higher in order to eliminate all the internal strains. At the higher heat the casting would undoubtedly sag out of shape by its own weight.

New Britain, Conn. R. S. BROWN

BALL-BEARING LATHE SPINDLE

Frequent references have been made of late in MACHINERY to the use of ball-bearings for the spindles of heavy machine tools. The accompanying drawing shows an example from actual practice of a spindle of a lathe of 16-inch center (32-inch swing) which has been in constant use for about two years. During the preliminary tests it was found that about 25 horsepower was needed for some of the cuts taken, although probably a 10-horsepower motor would have been ample for the ordinary duties of the machine.

The spindle runs at a speed varying from 22 to 505 revolutions per minute and has so far given no trouble whatever and has never required adjustment. The outside diameter of the front end of the spindle is 4¼ inches, and in addition to chucking work it can take bars up to 2½-inch diameter through the spindle. No vibration is felt under the heaviest cuts or during forming operations.

It will be seen that the thrust is taken at the front end by a double thrust bearing, the middle unit of which, together with the journal bearing, is clamped solidly to the front shoulder of the spindle by a notched nut, the bearings being retained at correct distances by sleeves or bushings. The retaining plates are clamped to the headstock by four fillister-head screws, as indicated. The one at the left-hand end of the bearing is adjusted once for all, it being considered advisable to make it impossible for the workmen to tamper with the adjustment. The argument for absence of facilities for adjustment is as follows: If adjustment should prove to be necessary after running, it would indicate that wear had taken place and if this happened it would only serve as a proof that the scheme
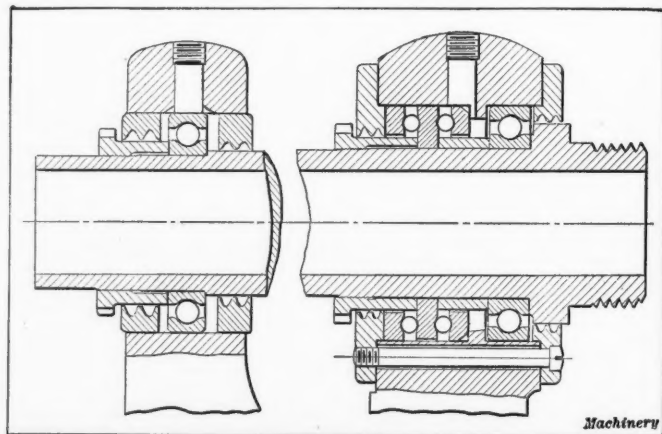
Mounting of Ball Bearings for Lathe Spindles

was a failure—at any rate, as regards the thrust bearings; and if the thrust bearings were subject to wear, the journal bearings would, in all probability, be subject to wear also. In fact, it may be said generally of ball bearings that wear proves that either they are unsuitable or the bearing is too small. In the particular arrangement shown it was thought that since the thrust bearings were very closely adjusted this had some influence in restraining vibration. S. PINDLE

LOCALLY CASEHARDENING GEAR AND CUTTER TEETH

In the May number of MACHINERY I noticed an item on casehardening gears without distortion, stating that the Cadillac Motor Car Co., of Detroit, Mich., has solved the problem by copper plating the teeth after the roughing cut, and then taking a finishing cut which removes the copper plating from the faces of the teeth; then when the teeth are casehardened only the faces of the teeth harden, the remainder staying soft.

This process may be new to the Cadillac Motor Car Co., but not to me and many other skilled mechanics. As long ago as ten years I made long reamers that way and later I made broaches 4 feet long for broaching keyways in automobile gears, hardening them by this process. The only parts of the broach that were hardened were the teeth, and it worked very successfully in the shop of which I was then foreman.

<div align="right">J. A. L.</div>

SPRING EJECTOR FOR PIERCING DIE

The accompanying illustration shows a device which in certain instances is useful in connection with piercing dies. With this device in use, flat blanks being pierced will be thrown out in front of the machine. The construction is simply as fol-
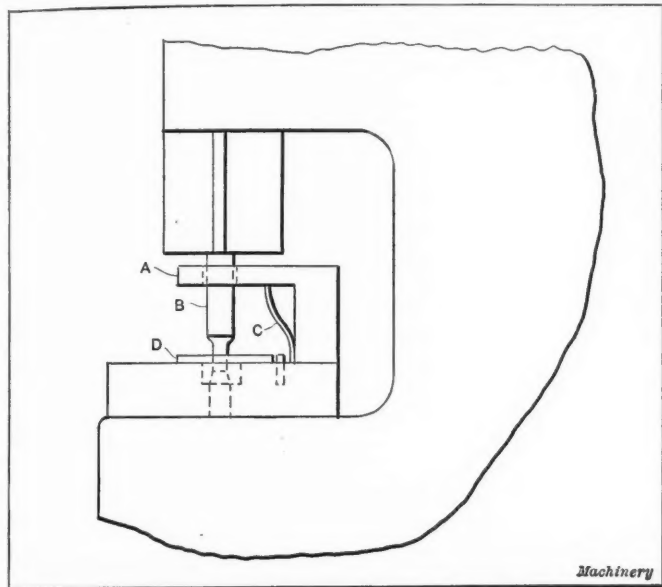
A Spring Ejector Arrangement for a Piercing Die

lows: The piece D when punched sticks to the punch B on the upward stroke, until it strikes stripper A, when it is stripped off. On its upward way, however, it compresses spring C, and is, therefore, suddenly pushed outward by the spring as soon as it is released from the punch. This device, while not new, may be of interest to many who have not seen it employed.

<div align="right">W. ALTON</div>

SUPERSTITION VS. COMMON SENSE

It is true that we no longer burn witches at the stake as did our Puritan forebears in Salem but superstitious beliefs are still too common to let us be very proud of our superiority. Common sense is a trait so uncommon that people endowed with it are regarded as uncommonly smart if not actual geniuses. In the past, MACHINERY has expressed a few ideas on the prevalence of superstition among engineers and others in charge of machinery. An engine or pump may have run satisfactorily for several years and then without apparent reason it goes wrong. After perfunctory tinkering and a half-hearted attempt to find the cause and correct it, the job is given up in despair by those immediately responsible for its operation. If it be a small, comparatively cheap apparatus it may be unceremoniously dragged out and replaced with a new one on the assumption that the old one is beyond hope, and a lurking belief is betrayed that no amount of repairs could have made the thing go. The men in charge may be able to learnedly discuss steam engine diagrams, heat units in steam, condenser capacity, etc., and would be righteously indignant if called superstitious.

To illustrate the attitude of workmen toward apparatus I will mention a case of an ordinary kitchen range in a rented house which gave trouble to the good housewife who essayed to use it. It would not bake or boil. The fire burned red and lifeless. Plumbers, experts and non-experts examined and agreed on a common verdict, "That range is no good; it must be replaced." Replaced it was, but the owner who is not a believer in witchcraft and who holds that the laws of nature operate without regard to location, set the stove up in his own house and quickly discovered the cause of the trouble—a wide

gap between the water back and the casing that let the air pass which should have gone through the fire and supported combustion. A few handfuls of furnace cement stopped the air leak and converted a worthless range into a thing of joy and a household delight.

No, superstitious beliefs in the mechanical world are not dead. They will live as long as ignorance exists and men are not taught to seek diligently and intelligently for causes and effects.

<div align="right">F. E. R.</div>

PREVENTION OF RUST ON TOOLS

No doubt a great many of the readers of MACHINERY have noticed the rust formation that takes place on tools within a few hours after they have been hardened in brine or in any of the numerous hardening solutions containing different salts used for this purpose. To counteract this rusting of tools, they should be boiled in a strong solution of soda water for fifteen or twenty minutes after having been hardened. Sal-soda (common washing soda) is the kind to use for the solution. A kettle holding about six or eight gallons of water may be used. About five pounds of soda are put in at the start, and after that about one to one and one-half pound is added every day. In this way the strength of the solution is kept about right. The addition of soda is necessary on account of the overflow which is required because of the method used for heating, the solution being brought to the boiling point by introducing steam. The work should always be boiled before being put into the tempering furnace and the latter should be at a temperature of about 212 degrees F. when the tools are changed from the soda kettle to the furnace. A basket arrangement with windlass may be used for raising and lowering the work to prevent scalding the hands. The directions given, if followed, will prove of advantage in hardening and tempering tools, in that the formation of rust will be prevented.

Decatur, Ill.
<div align="right">GEORGE COLES</div>

A MILLING ATTACHMENT FOR THE PLANER

The accompanying halftone illustrates a milling attachment designed for, and mounted on, a Putnam planer. This attachment is used for milling a great variety of work. It consists mainly of a horizontal head, a vertical head, a tailstock, and driving mechanism. The cutter heads are driven from the regular planer countershaft by means of a cone pulley mounted on the countershaft and belted to a cone
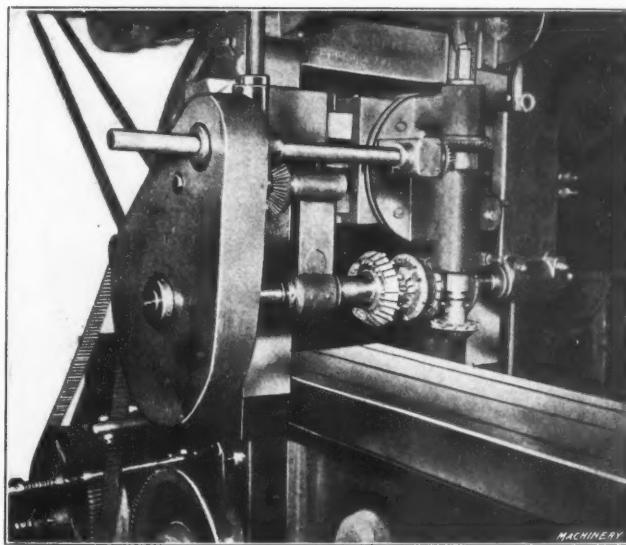
A Milling Attachment for the Planer

pulley on the main driving shaft of the attachment. A planetary gearing mechanism is provided to reduce the table travel to a rate suitable for milling. This mechanism is also driven from the regular countershaft on which is placed a small two-step cone pulley belted to a large two-step cone pulley on the planer, which carries the planetary pinion. The motion is then transmitted to the planer table by a Morse silent chain and sprockets, in addition to the regular gearing. The planetary gearing is of such a ratio that the

driven gear makes one revolution for every fifty revolutions of the cone pulley.
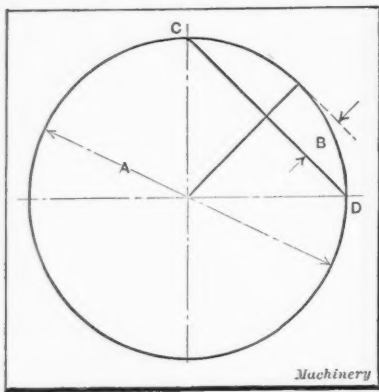
The attachment is very convenient and durable and has been in operation for eight years without any repairs. It is used on a planer with a 16-foot table. It is easily attached and detached. The planer is run back with the regular planer reverse belt, and, in general, is operated with the regular equipment for table travel, such as stops, etc.

Seneca Falls, N. Y.   W. H. RUNGE

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE ALONG·A STRAIGHT LINE

The accompanying illustration indicates a simple method for laying out the circumference of a circle along a straight line. This is frequently required in laying out cylindrical grooved cams, and in finding, graphically, the angles of thread helixes or spirals. The method is, briefly, as follows: Divide the circle by two diameters into four equal parts; then draw a line CD, bisect this line, and measure the distance B. This distance, added to three times the diameter, is a close approximation of the total circumference.

Laying Out Circumference of Circle

The accuracy of the method may be easily investigated. The distance B is the versed sine of 45 degrees, which equals 0.29289. This multiplied by the radius of the circle, plus three times the diameter, gives the approximate circumference obtained by this method. Assume, for example, that the circle is 4 inches in diameter; the actual circumference then equals $4 \times 3.1416 = 12.5664$. By the approximate method we obtain $3 \times 4 + 2 \times 0.29289 = 12.5858$. The difference between these two dimensions is negligible in ordinary drafting-room lay-out work. I believe this will be found helpful to readers who are looking for a simple graphical method which saves calculation or reference to tables.

Christchurch, New Zealand.   PERCY W. FRAMPTON

THREADING A DIFFERENTIAL GEAR CASE IN THE LATHE

The writer was recently confronted with the task of cutting an internal thread in a differential gear case for an automobile. The axle casings were riveted into the case
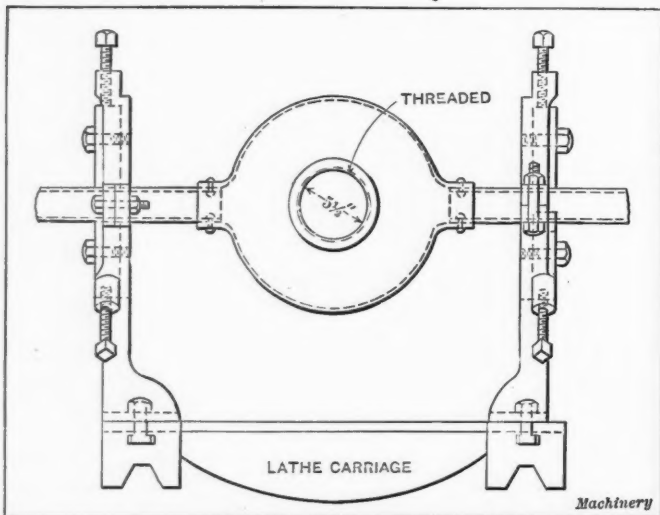
Threading a Differential Gear Case in the Lathe

as shown in the accompanying engraving, which prevented swinging the case in the lathe; hence, it was necessary to clamp the work to the carriage and use a rotating tool fastened to one of the chuck jaws. The clamping of the case was done as shown, the work being performed in a 28-inch

lathe. Steadyrests, which supported the work, were taken from two smaller lathes in the shop. These rests were bolted to the 28-inch lathe carriage. The jaws of the steadyrests clamped the work very securely, and furnished a simple method for setting the work central.

Denver, Colo.   STANLEY EDWARDS

FIXTURE FOR MILLING DOVETAIL SLOTS

Previous to the design of the fixture, the principle of which is shown in the accompanying engraving, the dovetail slot in the steel block A was cut with a 60-degree angular cutter, 7/32 inch in diameter, having a neck about 5/32 inch in diameter, and a No. 4 Brown & Sharpe taper shank; or in other words, a cutter was used of the same size and shape as the slot. A roughing cut was first taken with. an ordinary slitting saw. The finishing mill in that case, of course, had to be exactly to size, and to run true. High-speed steel was used for the mill, and a fine feed was required; the operator also had to exercise considerable care in starting the cut, as otherwise the cutter was likely to break.

By milling these pieces as indicated in the illustration, the cutter B can be made large in diameter; it is easily ground to the required angle and can be re-ground without materially affecting its efficiency; a coarse feed can also be taken. Another favorable feature of the fixture is that the slot is finished at one handling, although, of course, two cuts are taken. As will be seen, the cutter is mounted on a threaded arbor C.
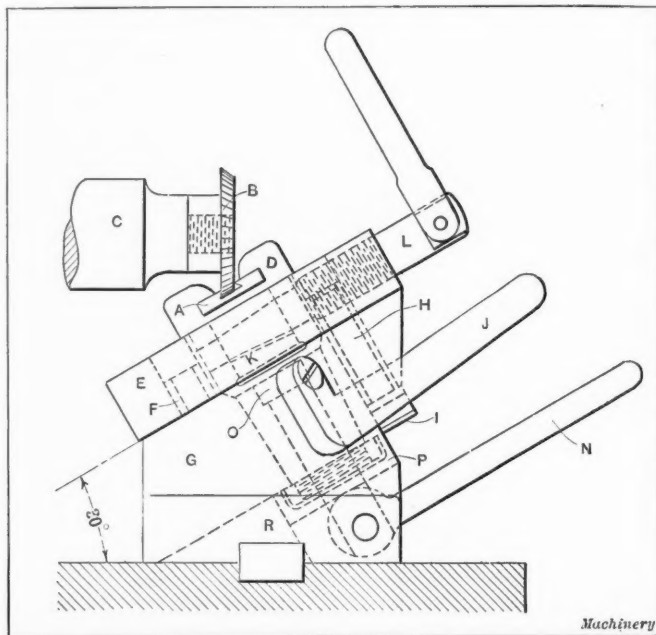
A Fixture for Milling Dovetail Slots at a Rapid Rate

The work is held in block D, which is the end of the spindle of the fixture. The square indexing plate E is keyed to this spindle. In this plate there are two bushed indexing holes F, 180 degrees apart. Chips are prevented from getting into these holes by plugs at the top of the plate. The base casting G is provided with the usual tongue to locate it in alignment with the milling machine table. The upper surface of this casting is machined at an angle of 30 degrees as indicated. As the axis of the spindle is inclined at right angles to the 30-degree surface of the base, one edge of the dovetail slot is brought at right angles to the center line of the cutter arbor. A 60-degree cutter is used, and as its width is a little more than one-half the distance across the bottom of the dovetail, the two cuts, the second of which is taken after indexing the work around, finish the piece. The index pin H is held in bushing F by a flat spring I. Lever J is used for pulling the pin H out before indexing.

The work A is clamped against the upper side of the slot in D by means of the plunger K, which is actuated through screw L, the handle of which acts as a wrench. The clamping is done by means of the wedge action due to the taper of screw L on that part of it which is inside of K. The spindle and plate E are clamped in position before taking a cut by means of cam lever N acting through cam-shaft O,

which has on its upper end a head for pulling the spindle down. Some of the details are rather obscure in this view, but it is all that is necessary to explain the principle involved.

East Orange, N. J.,   J. W. WEED and
Tottenville, N. Y.   S. J. PUTNAM

EXPANDING ARBOR FOR HEAVY TURRET LATHE WORK

The accompanying engraving shows an expanding arbor of heavy design which has proved satisfactory for rapid and accurate work on a heavy turret lathe. As will be seen, the arbor is intended to fit the chuck on the machine, and is provided with an expander having a bolt which extends through the entire spindle, this arrangement allowing for quick ex-
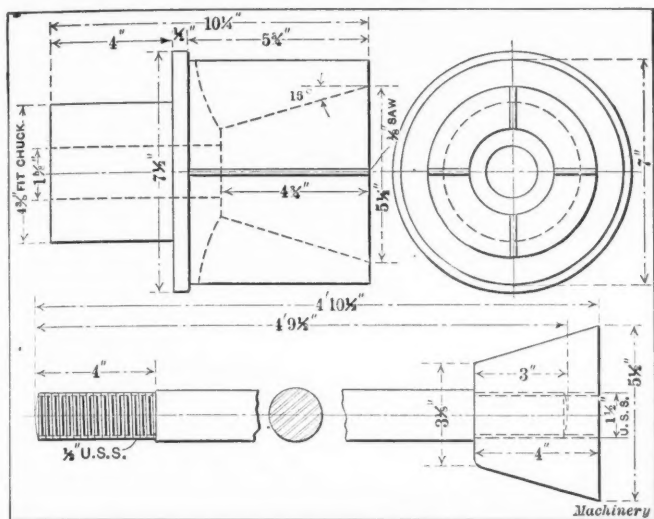
Expanding Arbor for Heavy Turret Lathe Work

pansion by means of a handwheel and washer on the end of the bolt. By means of this arbor the work is secured and held central for facing, turning or counterboring, independently of the chuck jaws, and the jaws are needed only to act as drivers. Whether the chuck is of the independent or universal type, it is possible to hold the casting true to the bore by means of this arbor, and a great deal of time is saved that is ordinarily spent in truing up work held by the chuck jaws only. At the same time, variations in the bore are taken care of by the expansion feature.   M. W. W.

METHOD OF WINDING SPRINGS IN A VISE

The accompanying illustrations show a method of winding springs in a vise. The writer has used this method for a number of years, but has never seen it described in MACHINERY. In the device, A is a rod so selected that it will give the correct inside diameter to the spring. The diameter of this rod
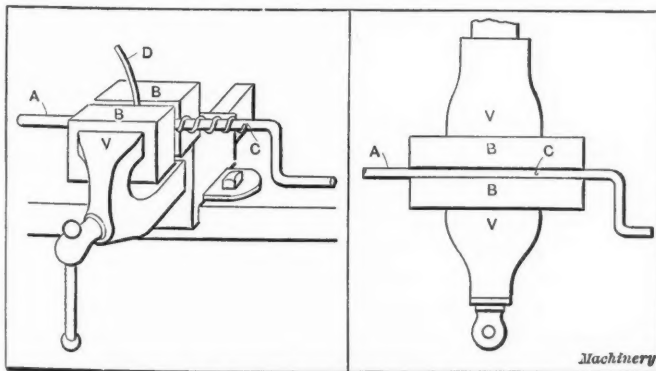
Winding Springs in a Vise

must be determined experimentally, as there must be some compensation for the enlarging of the spring when released. This rod is bent at one end to form a crank. A hole C is drilled near the crank end. This hole should be large enough to allow the end of the spring wire to enter. At B are shown hard-wood blocks, V being the vise jaws.

The rod A is clamped between the wooden blocks with the crank as close to the blocks as possible, and with the hole C

in a vertical position. The end of the spring wire is inserted into the hole. At the start the wire D must be guided so as to give the correct pitch. If held in a vertical position, the spring will be close-coiled. If inclined to the left, the coils will be open; the more the inclination, the wider the spacing. The first turn determines the pitch. After the first turn, a groove is formed in the wooden blocks and the wire will follow this groove. When the rod has passed through the blocks, or the wire has come to an end, release the blocks and cut the wire at hole C, thus allowing the spring to slide off the rod.

When springs are wound in this manner it seems that they do not enlarge as much in diameter when released as they do when wound in the lathe. The reason for using hard-wood blocks is that the wire "beds" into soft wood too easily.

Ft. Atkinson, Wis.   E. L. WHITE

HANDY TOOL-HOLDERS

The three tool-holders shown in the accompanying engravings have proved a valuable part of a toolmaker's equipment. In Fig. 1 is shown a splining-tool holder used for work where an ordinary holder cannot be used to advantage. The tools
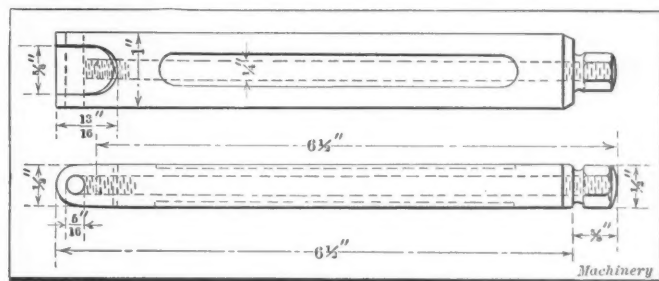

Fig. 1. Splining Tool Holder

are made of 5/16-inch drill rod, forged to the desired shape, and are firmly held in place by the clamping arrangement shown in the engraving. In Fig. 2 is shown a tool-holder for forming tools, when the cutters are made in quantities. This tool-holder is of considerable value; the forming tools may be
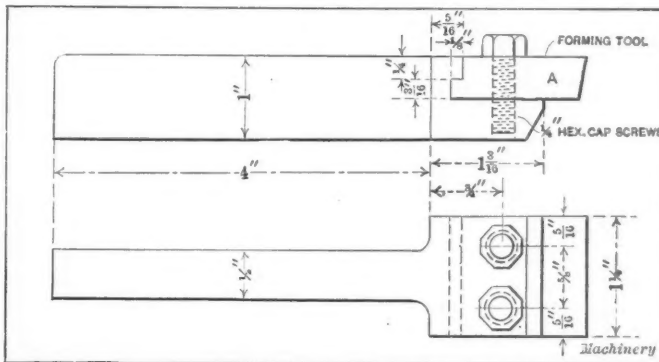

Fig. 2. Forming Tool Holder

made at low cost, and in case of breakage can be easily replaced.

In Fig. 3 is shown a tool intended primarily for threading operations, but it can also be used for light forming work. All parts of this tool are made of steel and casehardened.
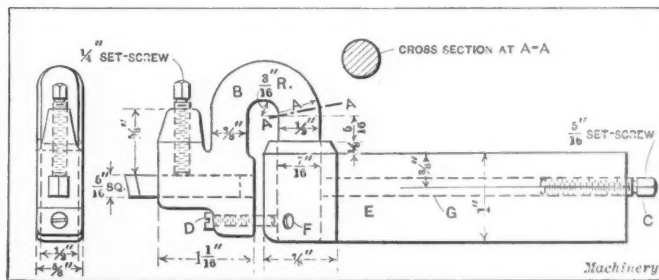

Fig. 3. Spring Threading and Forming Tool Holder

This tool is adjustable to three positions, right-hand, left-hand, and central. The head B is made a snug fit in body E, and is held in place by rod G, which is forced against it by set-screw C. Three flats are ground on head B so that it may be held rigidly in any of the three positions. Three holes F are drilled in the body E, one central, and the others at an angle of 30

degrees, on each side of the center, for the adjusting screw D. When the tool is used for threading, screw D does not reach fully down to part B, but a clearance of 1/32 inch is left. In this way the required elasticity of the threading-tool is provided for. When a rigid tool is wanted, it is only necessary to screw D tightly into place.

New Britain, Conn.   J. M. HENRY

A DRILL JIG FOR A NUMBER OF LEVERS

Fig. 1 shows four levers, M, N, O and P. The length l, the width of the hub h, the hole a, and the position of the lever arm in relation to the hub, are different in all cases, while the hole b is the same for all. The levers are machined in sets of four (one of each kind), which go through all operations together until they are ready for the machine for which they are designated.

The hole a is simply bored in the center of its hub, while b must be drilled by means of a jig, since the distance l from center to center must be absolutely correct. It would mean
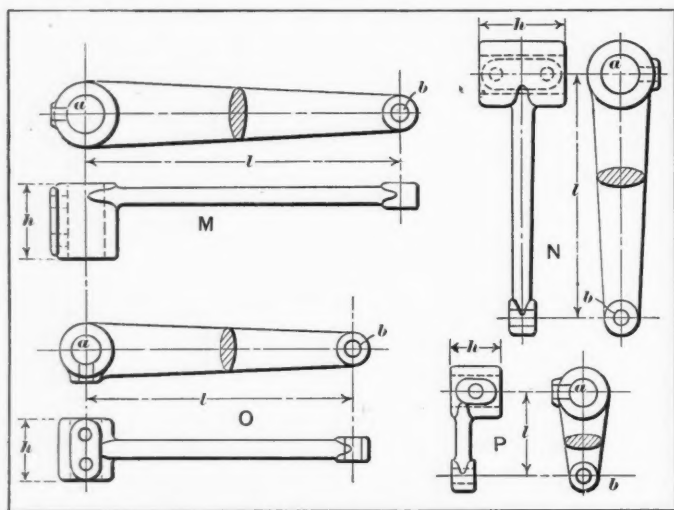
Fig. 1. The Four Levers to be drilled

a considerable loss of time, however, to change the jig for every lever, and the necessity arose, therefore, to design a jig which would allow the drilling of all the levers without taking the jig from the drill press table.

Figs. 2 and 3 show a jig constructed for that purpose. Fig. 2 shows a top view, a longitudinal section and a cross section, while Fig. 3 shows a general view of the jig with lever M in
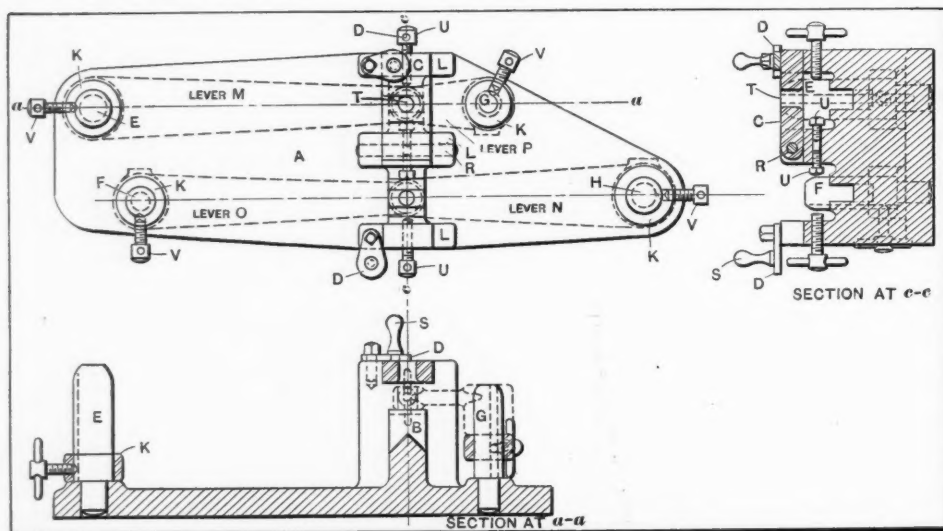
Fig. 2. Plan and Section of Drill Jig for Levers in Fig. 1

place. The jig consists of a cast-iron base-plate A which is cast with a projection B. This projection has three ribs L. The center rib is worked out to receive a hardened steel hinge C which swings about a pin R; C may be laid over to both sides, which are also worked out to suit the hinge. Each side is provided with a small steel lever D, with handle S, which serves to hold the hinge in its position while the jig is in operation. The guide hole T for the drill is used in both po-

sitions. The V-shaped part of B, directly underneath the guide hole (see section along a-a) aids the chips in falling off. Screws U are provided to adjust the levers sideways. The correct distances for the lengths of the various levers are laid off, as shown. At the points thus found, studs E, F, G and H are provided to suit the respective levers. A collar K is fitted to each of these studs. Every collar suits the hub of the lever
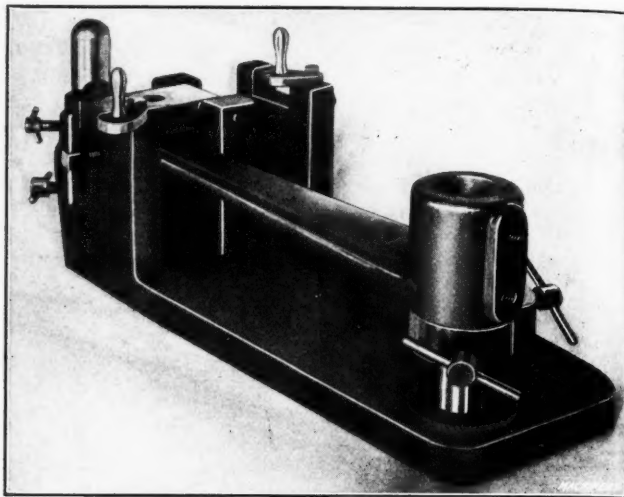
Fig. 3. General View of Drill Jig

which it is supposed to support, and may be fastened at any height by means of a screw V. The hardened center-point of the latter slides in a V-shaped groove provided for that purpose, thus preventing the collars from turning, and the handles of the screws from interfering with the body of the jig. Collars K hold the levers in the correct horizontal position.

Wyomissing, Pa.   CHRISTIAN F. MEYER

SUB-PRESS DIE FOR MAKING A CLEAT

The sub-press die shown in Fig. 2 was designed for producing the brass cleat shown in Fig. 1, this die superseding a set of simple dies previously used for the purpose. With the dies previously made, it required three operations to produce a cleat, the rehandling necessary causing considerable loss of time.

The base and upper portions of the sub-press die are made of cast iron, in the usual form, and are equipped with hardened and ground pins A to preserve the alignment of the upper and lower members. A cast-iron shank B, fitted in a T-slot cut in the upper member, serves to connect the latter with the ram of the press. Attached to the lower member or base is a hardened tool-steel block C mounted by means of screws and dowels on a soft-steel shoe D, and entering into a slot cut in the latter as shown. To the block C is held a "ribbon bar" E, which, in conjunction with the slot in the block F, serves to fold the edge of the cleat. The ribbon bar is held to block C by two horizontal dowel pins G, so that in case of breakage a new strip may be quickly inserted.

The lower member of the die is cut out to receive a spring pad H, which acts as a stripper for removing the cleat from the ribbon bar E. This pad is actuated by three helical springs I, and is limited in its upward movement by the shouldered screws J. The two guide strips K make provision for the entrance of the strip into the dies. A feed stop-bar L, mounted on the block C, controls the width of the finished cleat, and a stripper-plate M, sliding on the piercing punches N, holds the stock while the holes are being pierced. On the ascent of the press, stripper-plate M strips the cleat from the piercing punches. The stripper M is pressed downward by coil springs O, and is retained from further movement by the

shouldered screws *P*. The block *F* which acts as a bending punch is mounted on a soft-steel block *R* which, in turn, is attached to the upper member of the sub-press die.

The operation of this sub-press die is as follows: Stock of the correct width is fed in until the front edge of the strip is slightly beyond the shearing edge *Q* of blocks *F* and *C*. The first stroke of the press shears off the front edge of the

wear, but from which it was possible to approximately obtain the alignment in setting up. After removing the compound rest on the cross-slide, an emery-wheel stand made for the purpose was securely mounted in its place, and so adjusted that the axis of the emery-wheel shaft was in the same horizontal plane as the axis of the spindle. A stand was also set up on the carriage and secured to it by means of
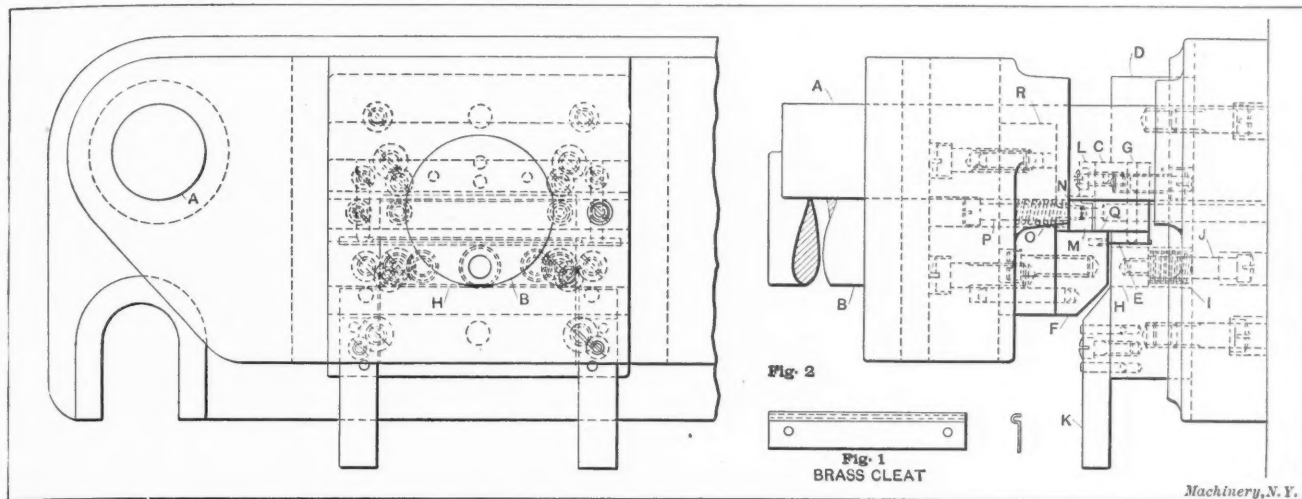
Figs. 1 and 2. Cleat and Sub-press Die for Producing it

strip, thus straightening it, and at the same time forming the bend in the blank. When the ram of the press ascends, pad *H* forces the bent strip from the ribbon bar *E*, so that the strip can be fed forward against the stop *L*. When the ram again descends, the holes in the blank are pierced, the first blank cut off, and the part for the next blank bent to the required shape. The finished cleat is ejected by means of a wooden pencil or rod, and the stock is fed in continuously in the manner described.

It will be noticed that the only scrap made is the small disks punched out of the strip by the piercing punches *N*. In practice, about 100,000 cleats may be punched without sharpening the die, for which, it will be noticed, due provision has been made. ARON LAWRENCE

Detroit, Mich.

GRINDING CALENDER ROLLS

In a small job shop in which the writer was recently employed some paper mill calender rolls were to be ground.

bolts in the T-slots of the saddle. This formed a support for a 3 H. P. motor for driving the emery-wheel.

As calender rolls cannot be ground on their centers, but must be ground to their bearings, a bracket *C* was made, the face of which had grooves fitted to the ways of the lathe and which was clamped in the same manner as a steadyrest. On the top of this was a skeleton pillow-block *A* (see Fig. 2) that could be moved and secured by means of set-screws. The first roll to be ground was the top roll, which was about 12 inches in diameter and weighed about 3700 pounds. One end was chucked as indicated in the illustration, and the other end was temporarily held by the tail-center, while the chuck end was trued up accurately. The pillow-block was then put under the bearing at the tail-stock end and babbitt was poured into it, after which the tail-center was withdrawn.

As the roll did not need to be ground to any specified dimension, but the one consideration was absolute parallelism, any instrument by which this latter could be ascer-
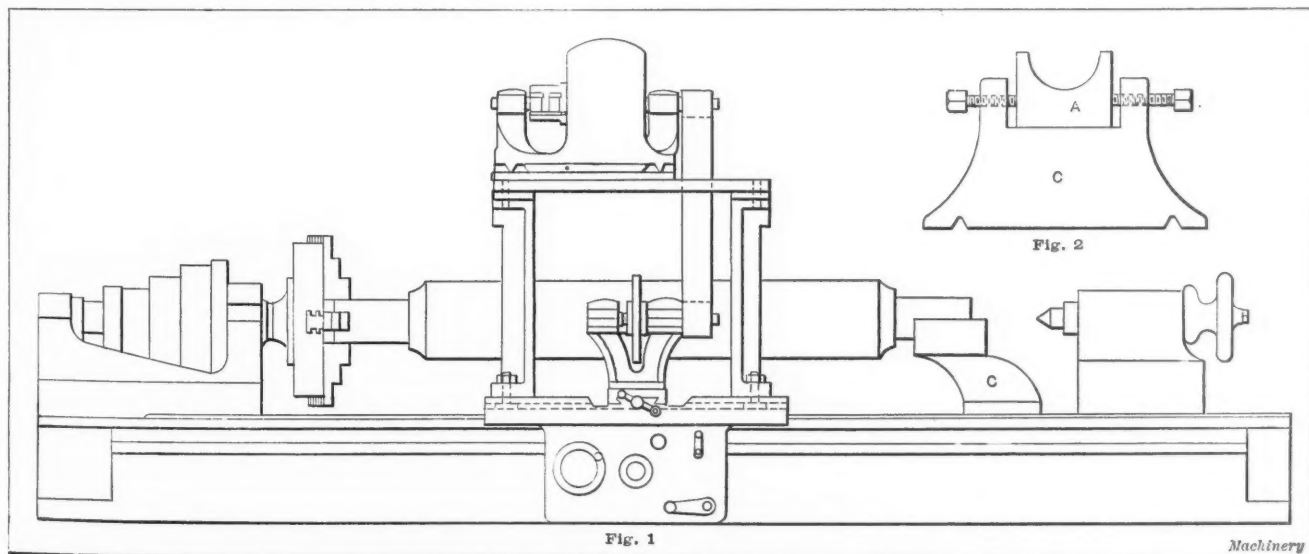
Figs. 1 and 2. Method of Grinding Calender Rolls in a Lathe

The machine in which the work was done was an 18-inch lathe with double back-gears. The length of the lathe over all was about 14 feet, and both ends and the middle support were set on masonry. The length of the face of the rolls to be ground was 74 inches, and as the width of the paper was 72 inches, there was left a margin of about one inch at each end of the roll which had not been subjected to

tained could be used. In this case we used a homemade measuring device which looked like an overgrown micrometer, for it had a range up to 16 inches. The measuring screw had 40 threads per inch and could be clamped in its nut. Both ends of the roll were trued up, that is, ground to equal size within a limit of less than 0.001 inch, this limit being obtained when the micrometer readings on the cross-feed

screw coincided at both ends. Then the entire length was ground, but, for some reason, the first roll was badly out of round and some time was consumed before the wheel would take an even cut over the entire length. On testing, we found the difference in diameter to be equal to six thicknesses of cigarette paper (the thickness of each paper was less than 0.001 inch). It took more than thirty hours to grind this roll. It was run at about 40 R. P. M., and the emery wheel was run at 1800 R. P. M. The diameter of the wheel was 10 inches, the face 1/2 inch, and the feed 3/16 inch. No water was used at any time.

Two wheels were used, the first a hard one but not very coarse, for the rough-grinding, and the second, a softer one, but somewhat coarser, for the finishing. The rough-grinding showed even "checks" about ½ inch wide all over the roll, and neither variation in the speed of the roll nor in the feed would eliminate them. In the writer's opinion, the comparatively slow speed of the wheel was the cause of this. The wheel should be run from 500 to 800 more revolutions per minute. After finish grinding with the softer wheel, the rolls were polished with fine emery dust and oil on a pine board. The other rolls, two of which were 6 inches, and two, 9 inches in diameter, were finished in the same way but at a comparatively higher speed. During the operation the oil holes were carefully plugged and the ways covered with canvas strips to protect them from the emery dust.

This was the third job of the same kind done in this shop. The owner said that he had been told, over and over again, that calender rolls could not be ground on engine lathes. He had, however, been able to accomplish this work satisfactorily. The only difficulty he met with was that on the first roll he found that the machine continued to grind several thousandths of an inch smaller in the middle, although sparks indicated an even cut the entire length. This difficulty he succeeded in eliminating by blocking up with paper between the frame and the middle leg on the back side of the machine. It took him, however, nearly two weeks to find this error and correct it.

It may be considered a good method to have one end of the roll gripped in a chuck as indicated. Personally the writer thinks that it would have been better if the roll had been placed in a bearing at the front end similar to that at the back. In one case, when a very heavy roll was ground, a dog engaged in the faceplate and gripping the neck of the roll—the latter being supported in bearings at each end— was used in order to relieve the spindle of the weight. This method, however, did not prove entirely satisfactory, as there seemed to be a certain spring in the tail of the dog that caused the drive to be uneven and produced something like corrugations in the roll, which were difficult to eliminate; hence, it was considered better to grip one end of the roll in a chuck.

As already mentioned, in truing up the chuck end of the roll, the other end was supported by a tail center. After truing the end as close as possible with chalk, the chuck and bearing were cleaned and covered with a thin film of lamp black, evenly smoothed out and neatly wiped off. A finely pointed scriber was clamped to the end of the emery-wheel stand and run up by the cross-feed screw. The roll was then revolved and adjusted by the chuck jaws until the scriber point traced a line evenly in the film all along the bearing.

Clinton, Iowa.   OLOF N. NORD

OBSERVING THE DEFORMATION OF MACHINE PARTS BY PHOTOGRAPHY

It was required to study the deformation caused by deflection in a motor car crankshaft, in order to determine which of the parts should be strengthened. A photographic method was tried and found to be very successful. The crankshaft was covered all over with white enamel, followed by a light coat of a black, opaque varnish; then, by the sharp point of a surface gage, lines were traced on the crankshaft showing the various axes, these lines removing the black varnish wherever drawn, and showing white on a black background.

The crankshaft to be experimented with was of the two-throw type for a four-cylinder motor. The shaft was placed on a cast-iron bed in such a way that it had only two bearing points at the center of its outside bearings, and so that the throws were in a vertical plane. Weights could be applied by means of a hook and a lever, the load being applied to the shaft at a central point. The weights could be attached without moving the shaft in its bearings.

A camera was then placed in front of the crankshaft in such a way that the plate was parallel to the plane of the shaft, and then one photograph was taken without any load on the crankshaft; then without shifting the camera and after having suspended the load from the center of the crankshaft, a second photograph was taken on the same plate, the result
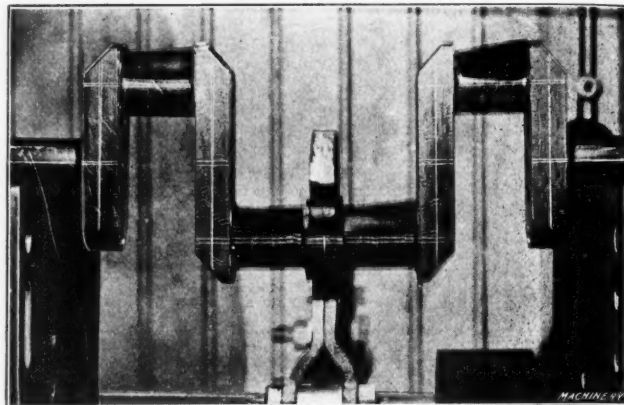
Deformation of a Motor Car Crankshaft as observed by Means of the Camera

being a composite photograph, as shown in the illustration. It will be seen that the white lines traced on the shaft are double, and the distances between two corresponding lines represent the deformation caused by the load at each point of the shaft. It will be seen that it is easy to determine which parts are the weakest, and, therefore, need strengthening. The lines on the central throws remain parallel to each other, which means that this part has not undergone any appreciable deformation. On the two vertical uprights, again, the lines are at an angle with each other which indicates that they have yielded and require greater strength. The distance between the two parallel lines at the place where the weight was attached was ⅛ inch under a load of 6600 pounds.

Turin, Italy.   C. BOELLA

AN ADJUSTABLE PIERCING PUNCH

To pierce a number of strips, as shown at A and B in Fig. 1, the adjustable piercing punch shown in Fig. 2 was designed, which obviated the necessity of making two separate piercing punch holders. This adjustable piercing punch was made so that the punch C could be forced back out of the way when it was necessary to pierce only one hole in the strip, as shown
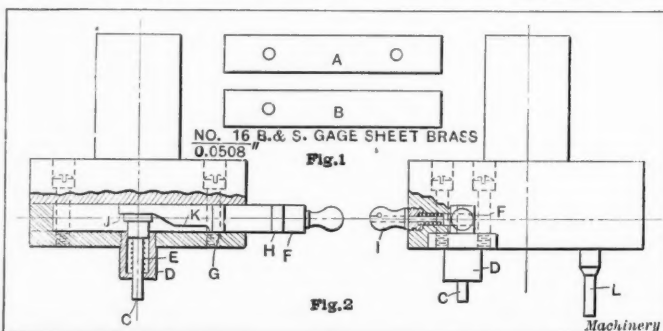

Fig. 1. Blank to be pierced.   Fig. 2. Adjustable Punch used in piercing the Blanks

at B in Fig. 1. This was accomplished by holding the punch C in a bushing D which is counterbored to receive the spiral spring E, the bushing D being screwed into the punch holder.

The punch C is provided with a head and is brought into or out of action by means of the cam plunger F, the latter being provided with two slots G and H in which the spring-actuated plunger I fits. When the punch is out of action it rests on the cam face J, the spring-actuated plunger I fitting in the slot G, and when it is in action the cam plunger F is pushed in so that the head of the punch C bears against the

cam face K, the spring-actuated plunger I fitting in the slot H. The other piercing punch L is fastened in the punch holder in the usual manner. The die, of course, is provided with two holes. As can be seen, it is a simple matter to make this punch either into a one- or two-hole piercing punch.

Rochester, N. Y.　　　　　　　　　　W. R. HUMELBAUGH

REAMING MARINE ENGINE SHAFT COUPLINGS

As shown in the accompanying engraving, solid flange couplings are used for connecting marine engine shafts. Tapered bolts fasten the flanges together and keep the shafts in alignment. If there is a sufficient amount of work of the same size, a jig may be used for drilling the coupling holes; if not, the holes are marked off and drilled as accurately as possible without a jig. After removing the burrs from the coupling faces, temporary bolts are used to fasten the couplings together, and the edges of the couplings and the holes are brought into alignment. An ordinary steel straightedge A when tried at top and bottom and on both sides of the edges of the couplings will show when they are in line. This part of the work must be carefully done; otherwise the journal portions of the shaft will not run true. The bolt-holes are then reamed, a reamer often used for this work being shown at B in the engraving. It is tapered and consists of a two-edged cutter with pieces of hard wood packing, the whole arrangement being held together by screws.
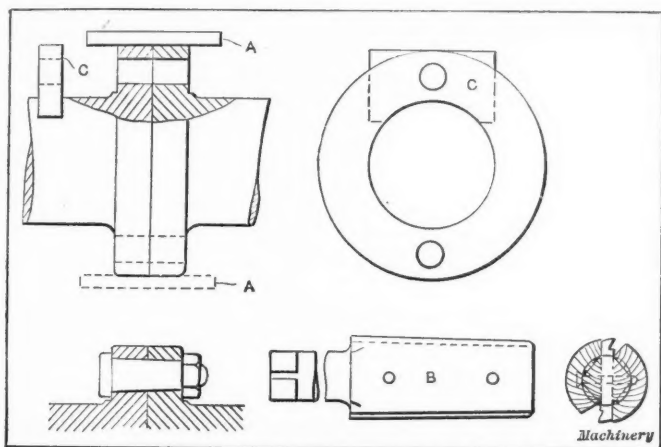
Method of Connecting Marine Engine Shafts, and Reamer used for Reaming the Taper Bolt Holes

The hard wood pieces steady the cutting edges, and the shank is supported, during the reaming operation, in a plain bearing block C of hard wood or cast iron. A slight clearance should be allowed under this bearing block, as the holes may vary slightly in their distance from the shaft center, and the bearing block can be adjusted to the correct distance from the center by packing pieces of tin or sheet iron. If greater accuracy is required, a roughing and finishing reamer may be used, although one reamer is often sufficient. For small holes the reamer is frequently turned by a hand ratchet, no support being required, while, in the larger sizes, some portable means for driving that is available may be used. While reaming the holes, the alignment of the reamer should be tested two or three times to see that it is square with the flange. If the holes are not drilled exactly in line, the reamer may have a tendency to draw to one side. After fitting a tapered bolt in the first hole, the hole opposite should be reamed next and also fitted with a bolt; afterwards there will be no danger of the couplings shifting while reaming the remainder of the holes. The bolts are driven in tight with a heavy hammer. This type of coupling is used when a three-throw crank is built up of separate parts.

Govan, Scotland　　　　　　　　　　W. BURNS

REDUCING THE DIAMETER OF A RING

The writer recently met with an interesting job in the form of one thousand cast-steel rings that were to be shrunk on to the hubs of motor truck wheels. The rings were of rectangular section, $10\frac{3}{8}$ inches inside, and $16\frac{1}{2}$ inches outside diam-

eter. The thickness was $1\frac{3}{4}$ inch. These rings were faced on one side and bored to within a limit of 0.002 inch. The work was done in small lots, covering a period of more than six months, and different men and machines were employed on the work; hence, quite a number of the rings were bored too large. The specifications in connection with this work did not permit any forging to be done on these castings, and the appearance of any hammer marks would not have been permissible. A satisfactory method for shrinking the diameter of the rings, however, was developed. The rings were heated to a bright cherry red in a furnace, and then hung on a piece of pipe laid across a tank of water as indicated in the accompanying illustration. The level of the water in the
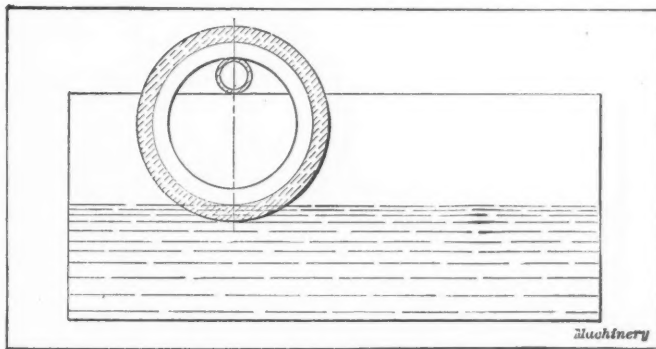

Method of Reducing the Bore in a Ring

tank was so gaged that the outer edge of the ring only was immersed. As the pipe was rolled along the tank, the outside of the ring was rapidly cooled, and in shrinking forced the inside stock inward so as to allow enough stock for reboring.

Rochelle, Ill.　　　　　　　　　　J. H. MAYSILLES

USING A TRIANGLE TO FIND CENTERS OF RADII

Anyone who has parts to draw requiring a number of radii no doubt will appreciate this method of locating the centers. An ordinary draftsman's triangle is laid out as shown in the accompanying illustration, for radii varying from 1/16 to 1/2 inch, advancing by sixteenths of an inch, and from ½ to 1 inch, advancing by eighths of an inch. An easy way to lay out the holes in the triangle is to use a surface gage to scribe the
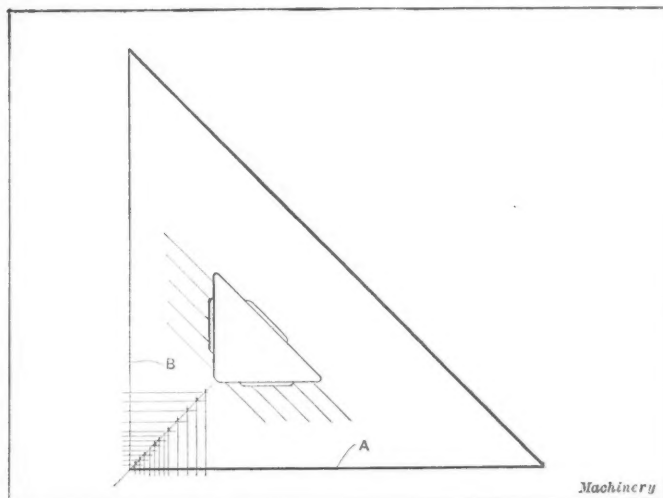
Triangle for Locating Centers of Radii

lines, placing the triangle on a surface plate. The holes drilled in the triangle should be of the same diameter as the needle point on the compass.

To use the triangle, place the sides A and B tangent to the lines to be connected with the radius, usually a quadrant, and prick the center with a needle point. If the holes in the triangle are accurately spaced, any radius within the range of the triangle can be easily and quickly laid out.

New Britain, Conn.　　　　　　　　　　J. M. HENRY

* * *

A writer in the *Iron Age* states that by the extrusion process zinc may be transformed into a fine, crystalline structure, the tensile strength of which is 23,000 pounds per square inch.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for
this department. Write on one side of the paper only and
draw sketches on separate sheets.

TO PREVENT THE FILE FROM CLOGGING

The following kink is probably known by most machinists
but it may be helpful to some of the young fellows. When
filing a poor quality of wrought iron in the lathe I had much
trouble with the file clogging up, until I found that by bear-
ing down slightly on the return stroke the offending chips
would be removed.   W. K.

EFFECTIVE MEANS OF HOLDING A CUTTER IN A BORING-BAR

The accompanying illustration shows a simple and effective
means of holding a cutter in a boring-bar, which has been
used successfully for boring car-wheels. The end of the bor-
ing-bar A is tapped out to receive the hexagon clamping
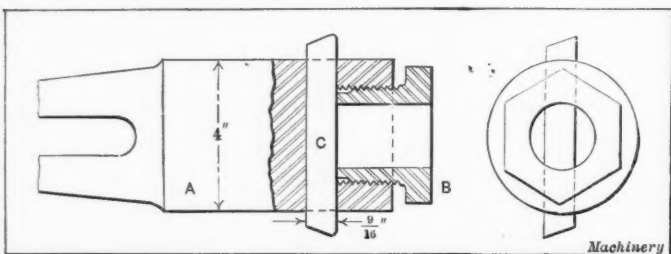
screw B, which holds the cutter C firmly in the bar, preventing
it from chattering or moving. The clamping screw B is case-
hardened on the end, and is made hollow so that the cutter
will be held more firmly.

Vancouver, B. C.   J. C. MATTISON

DEVICE FOR LIFTING LOCOMOTIVE DRIVING WHEELS

The accompanying illustration shows a simple device which
the writer recently saw employed in a Western shop for
lifting locomotive driving wheels. This device could also be
used to advantage for lifting large pulleys, etc. It consists
essentially of three prongs or hooks (one of which is not
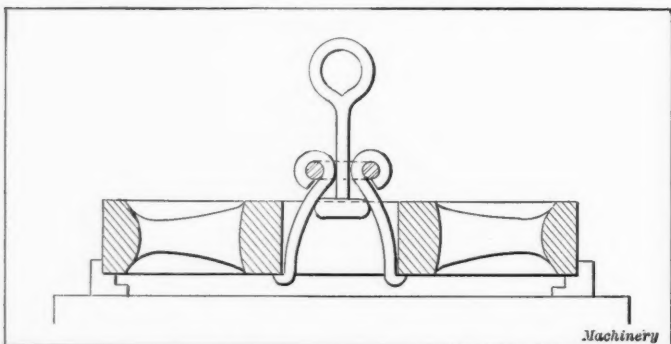
shown) made from ¾-inch round iron, a welded ring and an eye
having an enlarged end for opening the hooks which grip the
wheel by the hub.   M.

BABBITTING BOXES

In using a shaft as a mandrel to babbitt boxes with, I have
found from experience that wrapping a piece of paper around
the shaft before placing it in position will make a good clean
piece of work—smooth and glassy. The paper may be pasted
on the shaft with shellac or glue where the edges meet. Let
the paper extend the full length of the box and the edges just
meet on the shaft. The paper, besides making the babbitt run
smooth, also provides a little clearance, and the bearing does
not require so much scraping. Those who do not care to use
paper will get a smooth bearing by rubbing chalk on the shaft
before babbitting.

I have seen a good many mechanics pour babbitt in boxes
without venting them and then wonder why it is that they
have to patch so much. I have always worked under these
rules in running babbitt and have had good success:

First, always have plenty of vents; second, make the bab-
bitt good and hot; third, pour the babbitt as fast as it will flow
through the pouring hole, and always use a few drops of oil on
the risers.

Montpelier, Ind.   J. T. CROMACK

PREVENTING A ROUND BELT FROM SLIPPING ON A GROOVED PULLEY

It is sometimes found necessary to use a round belt and a
V-pulley in order to avoid a com-
plicated mechanism. One of the
difficulties which arises from using
a small V-pulley is the slipping of
the belt. This can be avoided by
making the pulley as shown in the
accompanying illustration. It is
made in the ordinary manner but
is provided with spaces which are
cut out at intervals in the sides of
the face. This type of pulley com-
pletely overcomes any slipping of
the belt.   F. D.
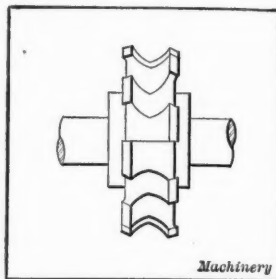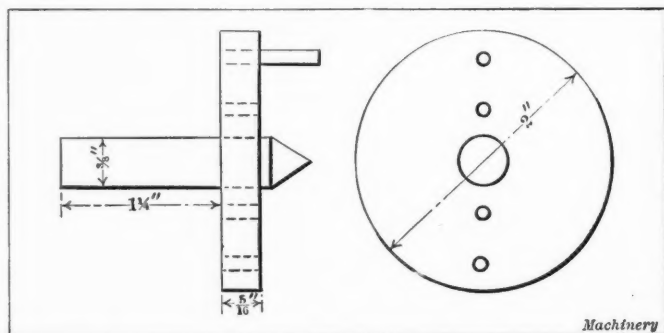

TO PREVENT SCALE ON DIES WHEN HARDENING

A good way to prevent scale on dies when hardening is to
dip them in water before they are heated and then put them
into dry salt, letting all the salt that will, cling to them.
After this the pieces are heated and immersed in brine as
usual. The scale or crust of salt will fall off in the water.
The piece so treated will have the appearance of a piece which
has been heated in cyanide.   DONALD BAKER

Syracuse, N. Y.

HANDY CENTER FOR SMALL WORK

The writer recently had occasion to turn some small work
in a regular 16-inch lathe. It was difficult to drive this work
when mounted on the regular centers. Therefore, a small
center with a miniature faceplate, as indicated in the accom-

panying engraving, was made, this center being held in a collet
chuck in the lathe. The holes in the faceplate were drilled
to fit a standard size wire, the wires being used to drive the
work. This device was found to be very handy in turning
and threading small thumb-screws and similar work.   S. C.

TURNING SOLID DISKS

I had to make six disks about 2¼ inches in diameter from
sheet brass; they had to be turned true to size, and as there
was no hole through them they could not be placed on an
arbor. I cut them out with the shears, about 1/16 inch large,
and then put them between two disks of wood a little smaller
than the finished size of the brass disks. After knocking out
the live center of the lathe, the disks were pressed firmly
against the faceplate with the "dead" center. Of course, a steel
disk was placed between the "dead" center and the wood, so
that the center would not cut into it. After truing the disks
central, I found that they could be turned very nicely by tak-
ing a light chip, as the pressure of the center against them
was sufficient to prevent them from slipping. The object of
using the wooden disks was to increase the friction, so the
brass disks would not slip.

Mansfield, Mass.   LESTER P. BROWN

HOW AND WHY

**DEPARTMENT INTENDED TO CONTAIN CORRECT AN-
SWERS TO PRACTICAL QUESTIONS OF
GENERAL INTEREST**

Give details in full and name and address. The name and address will not
be published with the answer.

TO DESIGN A CIRCULAR BEAM

G. A. W.—I have a circular beam made of steel angles and
plates in I-beam section to design, and would like to know
how to calculate the bending moment for a uniformly dis-
tributed load around the inside of the ring; also the pitch of
rivets in the angles. The illustration shows the method of
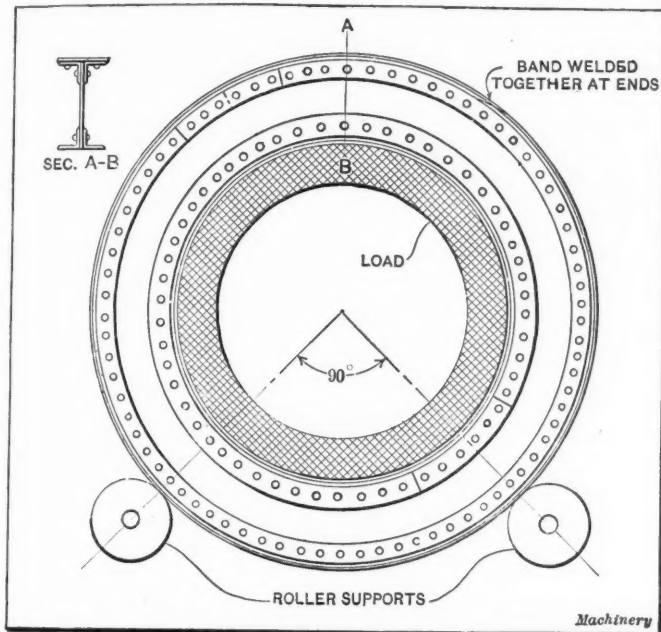
Circular Beam to be designed to support Load in Rotation

loading and supporting the ring. The ring revolves once in
ten minutes and then stands stationary for twenty-four hours.

The question is an interesting problem in machine design
which would form the subject of a good article. An answer
is desired in this form.

CHANGE GEARS FOR SPIRAL GEAR-HOBBING MACHINE

R. E. N.—Two spiral gears are to be cut on a gear-hobbing
machine. Gear No. 1 has 30 teeth, 24.549-inch lead, and a feed
of 1/24 inch. The change gears used on the machine for cut-
ting a spur gear with 30 teeth have 48 (driving gear) and 60
(driven gear) teeth, respectively. The hob and gear are of
the same "hand."

Gear No. 2 has 60 teeth, 49.098-inch lead and is cut with a
feed of 1/16 inch. The change gears used to cut a spur gear
with 60 teeth, on this machine, have 48 and 40 teeth, for the
driving gears, and 60 and 80 teeth, for the driven gears. The
hob and gear are of the same "hand."

A.—The method to follow for calculating these gears was
explained in the December, 1911, number of MACHINERY, engi-
neering edition, and the formula there given for calculating
gears to use for hobbing spiral gears, was as follows:

$$\frac{L \div F}{(L \div F) \pm 1} \times \frac{P}{p} = \frac{S}{s}$$

in which

L = lead of spiral,
F = feed per revolution,
P = product of driving gears for cutting spur gears with
same number of teeth,
p = product of driven gears for cutting spur gears with
same number of teeth,
S = product of driving gears for cutting spiral gears,
s = product of driven gears for cutting spiral gears.

Use $+$ sign when gear and hob are of opposite "hand," and
$-$ sign when they are of the same "hand."

In the problems given the data are as follows:

	30-tooth Gear		60-tooth Gear
L	24.549	L	49.098
F	1/24	F	1/16
P	48	P	40×48
p	60	p	60×80

Calculations for Thirty-tooth Gear

By inserting the values given, we find that:

$$\frac{L \div F}{(L \div F) - 1} = \frac{589.176}{588.176}$$

For our purpose, the ratio written above can be simplified
to the form $\frac{589}{588}$. Factoring, we have:

$$\frac{589}{588} = \frac{19 \times 31}{12 \times 49}$$

Now, multiply this value with the ratio of the gears for a
30-tooth spur gear:

$$\frac{19 \times 31}{12 \times 49} \times \frac{48}{60} = \frac{76 \times 31}{60 \times 49}$$

Having obtained the gears that should be used, we may now
investigate what lead these gears will give. Apparently they
will not give the exact lead desired, as we have used an ap-
proximate ratio instead of the exact one.

To prove, assume $F = 1/24$ and solve for L.

$$\frac{L \div F}{(L \div F) - 1} = \frac{589}{588}$$

From this we find $L = 24.541$, which is very nearly equal to the
required lead.

Calculations for Sixty-tooth Gear

By proceeding in the same way for the 60-tooth gear we have:

$$\frac{L \div F}{(L \div F) - 1} = \frac{785.568}{784.568}$$

We then factor the fraction $\frac{785}{784}$, thus:

$$\frac{785}{784} = \frac{5 \times 157}{4 \times 196}$$

As 157 is a prime number, and gives too large a number of
teeth for any of the gears in the train, we try $\frac{784}{783}$ which ratio
is very nearly equivalent to that required.

$$\frac{784}{783} = \frac{49 \times 16}{29 \times 27}$$

Multiply this value with the ratio of the gears for a 60-tooth
spur gear:

$$\frac{49 \times 16}{29 \times 27} \times \frac{40 \times 48}{60 \times 80} = \frac{49 \times 32}{29 \times 135}, \text{ or } \frac{49 \times 32}{87 \times 45}$$

Possibly the 135-tooth gear is impracticable, on account of
being too large, in which case the other combination must be
tried.

If the lead resulting from the gears found is calculated in
the same manner as in the previous case, we find that

$$L = 49.001$$

Influence of Small Changes in the Ratio on the Lead

It is interesting to note that a comparatively slight change
in the ratio $\frac{L \div F}{(L \div F) - 1}$ makes a very decided change in the
lead obtained. To illustrate, assume that in the first ex-
ample given the ratio $\frac{589}{588} = 1.001701$ were changed to 1.002;
let us see what effect this change would have on the lead ob-
tained $(F = 1/24)$:

$$\frac{L \div F}{(L \div F) - 1} = 1.002$$

If we solve for L in this equation we find $L = 20.875$, which is
a very different lead from the one we wish to obtain.

DROP-FORGING A WRENCH BAR

B. L. E.—I desire to make drop-forging dies for the piece
shown in Fig. 1. This piece is to be a steel forging and the
principal point on which I desire information is the proper
shaping of the breakdown in order to distribute the stock so

that I can get the head. Also advise me what size bar steel to use and to what length the bars should be cut for forging.

Answered by J. W. Johnson, Revere, Mass.

A.—For drop-forging the piece shown in Fig. 1 a pair of drop-forging dies fitted with forming and finishing impressions, breakdown and anvil will be required. The lower half of a suitable pair of dies is shown in Fig. 2. Fig. 3 shows the right-hand side elevation of the dies, giving an idea of the shape of the breakdown, and Fig. 4 is a left-hand side elevation to show the general proportions of the anvil required for drawing out the stock. The principal requirements of a pair of dies for drop-forging this piece are that the stock be so distributed by means of the breakdown and anvil that there will be little for the face impressions to do except to shape the sides of the piece. Referring to Fig. 2, the anvil shown on the left-hand side of the die should be given the first consideration. The function of this anvil is to draw the steel out for the handle of the wrench to such dimensions as will fill the face impressions when struck therein. Thus, as the size of stock to be used will be approximately 2 by ¾ inches, it is evident that a section of the two-inch width must be drawn down by means of the anvil to such size as will just fill the face impression of the wrench handle. Referring to Fig. 1, it will be seen that the section of the handle of this wrench measures approximately ½ by ⅞ inch. It is not necessary, however, that the stock be drawn to these exact dimensions but it must be drawn to a squared size whose section is about equal to ⅞ by ½ inch, which in this case would be
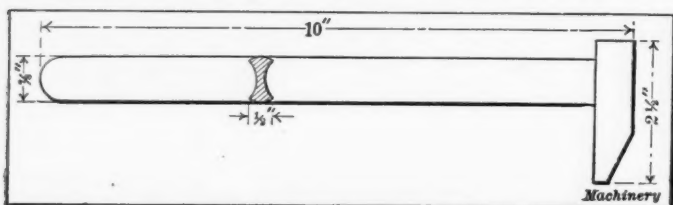
Fig. 1. Wrench Bar to be forged

about 11/16 inch. In making the anvil, therefore, the two faces should be shaped away until these faces are 11/16 inch apart when the dies meet. The removal of the stock back of the anvil faces is merely for clearance. As in all drop-forging operations, after the preliminary roughing down of the stock is accomplished by means of the anvil, it is necessary to strike the steel in the breakdown in order to approximately
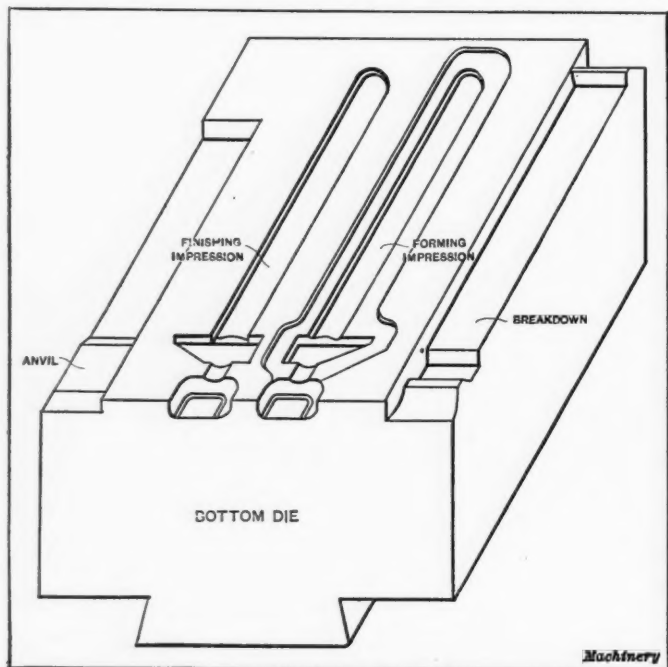
Fig. 2. Lower Half of Drop-forging Die

shape the forging. Referring again to Fig. 2 the lower half of the breakdown may be seen, and by referring to Fig. 3 the outline of the entire breakdown is seen. This breakdown should be about 1/16 inch smaller all around than the finished work is to be, in order to squeeze the stock so that it will lie in the impression for striking the final blows. All corners

should be well rounded to avoid cold-shuts. It will be noticed that the width of the stock recommended is 2 inches while the height of the wrench bar head is 2½ inches. This is explained through the fact that the steel will spread the necessary amount to make up the difference. It would be possible to drop-forge this piece with but one face impression, but if many pieces are to be made it would be far more economical
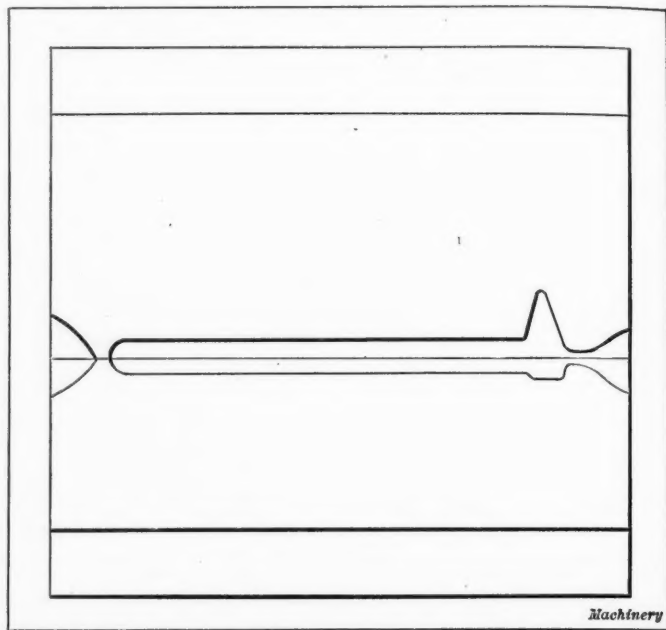
Fig. 3. Right-hand Side Elevation of Dies, showing Breakdown

to provide the dies with forming and finishing impressions as shown in Fig. 2. The forming impression should have all corners and edges well rounded in order to facilitate the flowing of the metal. This impression should be "flashed" and the upper die provided with both flash and gutter. For information in regard to cutting the flash and gutter, see "Drop-forge Die-sinking," Parts 1, 2 and 3, commencing in July, 1911,
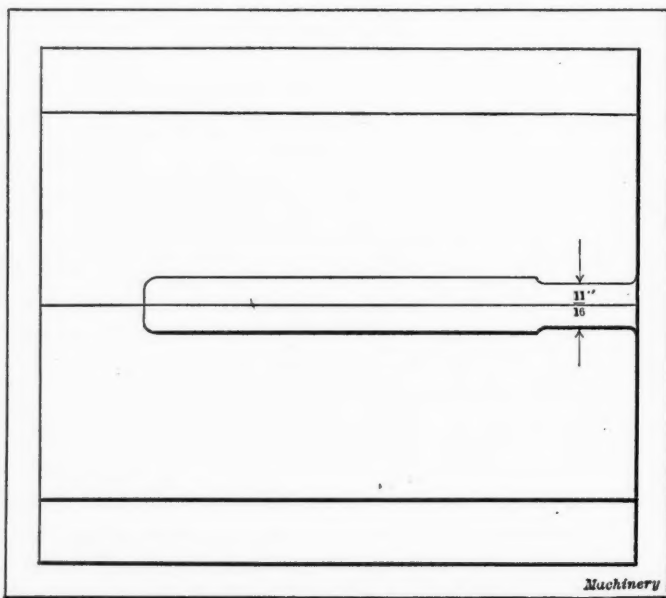

Fig. 4. Left-hand Side Elevation of Dies, showing Anvil

engineering edition of MACHINERY. The finishing impression is, of course, made exactly as the finished part must be shaped and is only used in striking the few final blows.

It is impossible to state the exact lengths to which the bars of steel should be cut for forging. This can best be determined by first cutting a length of stock from the bar as long as can be conveniently handled; say five or six feet in length. At the time of forging the last piece, it can then be seen if the bar could best be used slightly longer or shorter in order to come out with an even number of finished forgings.

* * *

Monel is said to be the only commercial metal that will resist the corrosive action of liquid soaps.

NEW MACHINERY AND TOOLS

WALKER "UNIMATIC" TOOL-ROOM GRINDER

The Walker Grinder Co., of Worcester, Mass., is now manufacturing a special grinder which is designed to meet all the requirements of modern tool-room practice. This machine, which is known as the "Unimatic" tool-room grinder, is not intended to replace the well-known No. 2 universal grinder built by this company, as it does not have as great a capacity. The new design embodies, however, all the universal features of the No. 2 size, with the addition of certain adjustments made possible by the novel construction.

The machine is very compact and entirely self-contained, no overhead works being required. The work-spindle is rotated by a flexible shaft, which is shown to the left of the

Fig. 2. Grinding an Inserted-tooth Cutter on Walker Grinder

Fig. 1. Universal Tool-room Grinder, built by the Walker Grinder Co.

machine in Fig. 1, so that the overhead belt drum is eliminated. The initial drive is from a shaft in the base which transmits motion to the grinding wheel, the work-spindle and the table reciprocating mechanism. The arrangement of the interior shafts and driving belts, is shown by the end and front elevations, Figs. 4 and 5. The main shaft A carries tight and loose pulleys at the rear end (see also Fig. 2) and a three-step pulley in the center, which drives another three-step pulley mounted on shaft B. Shaft B also carries a large pulley C, which connects by a belt with the grinding-wheel spindle. Shaft A drives the intermediate feed shaft D by means of step pulleys, and shaft D, in turn, transmits motion to the table feed shaft E, which is also provided with step pulleys.

The initial driving shaft A connects with shaft F by means of step pulleys, and F is geared through fiber gearing to a second shaft G, which, of course, revolves in an opposite direction. The front ends of each of these shafts are recessed and arranged for attaching the flexible shaft H, which transmits motion to the work-spindle. This flexible shaft is clamped in

Fig. 3. Application of Motor Drive to Walker Grinder

place by screws and it can readily be attached to either F or G, according to the direction of rotation desired. The motion of the flexible shaft is controlled by handle I which connects with a friction clutch operated by a coil spring.

Hinged in the base of the column there is a frame J carrying an idler which is held against the belt connecting shafts A and B by a coil spring, so that constant tension is maintained. When it is desired to change the belt on the pulley, this tension is removed by withdrawing handle K; then the belt can easily be shifted through an opening in the side of the column. The driving belt operating on the tight and loose pulleys at the rear of shaft A, is shifted by a belt-shifter L, conveniently located at the front of the machine.

Upon the main base of the machine there is a pedestal M carrying the feed gearing and supporting the grinding-wheel housing N, which, by simply loosening one screw, can be swiveled 90 degrees about a vertical axis in either direction. Upon housing N is mounted the wheel-slide O, which is raised or lowered by a vertical screw, operated through bevel gears and the handle seen near the top of the machine. On the top of housing N is mounted an idler bracket P, which is provided at its lower end with a sleeve of large diameter through which the driving belt passes. This sleeve is threaded upon its exterior with a square thread of coarse pitch and the outside of this thread centers the sleeve in housing box Q when the housing is swiveled.

The grinder carriage R is mounted upon the pedestal M and slides on elongated V tracks which are lubricated automatically with rollers operating in oil wells. This method of lubrication is also provided for the platen S, upon which is mounted the swiveling platen S_1. This swivel platen, which carries the headstock and tailstock, can be set for tapers up to three inches per foot and has a fine

by three cap-screws passing through slots and providing an adjustment for the short belt which rotates the driving faceplate.

The headstock has a universal chuck-spindle which can also be driven from pulley U. This chuck-spindle is interchangeable with the spindle which carries the revolving faceplate.
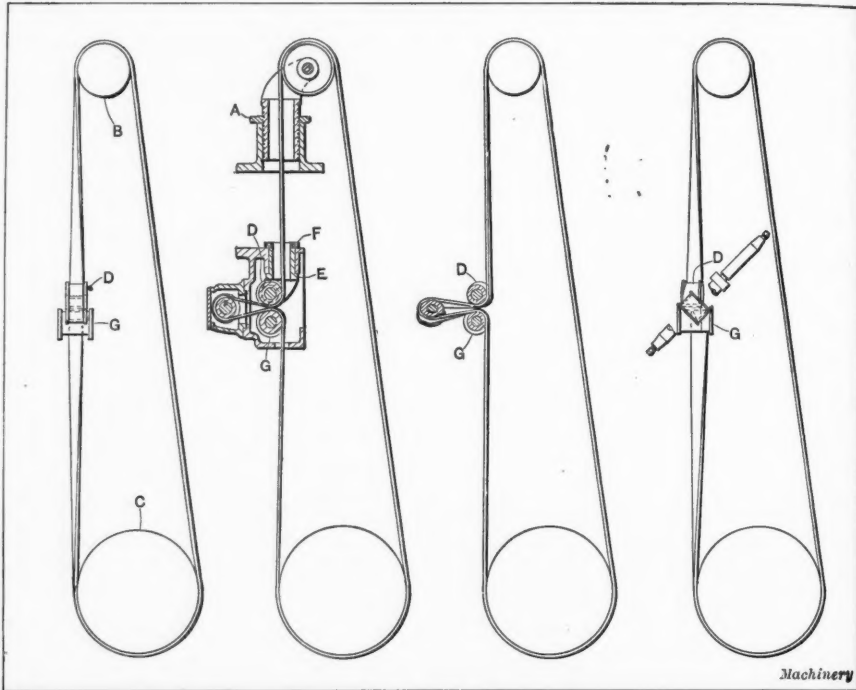
Fig. 6. Showing Course of Spindle Driving Belt for Various Positions of Grinder Head

The chuck-spindle, the driving faceplate and the flexible-shaft bearing are reversible in heads, so that the drive can be from whichever end is most convenient. This feature is found de-
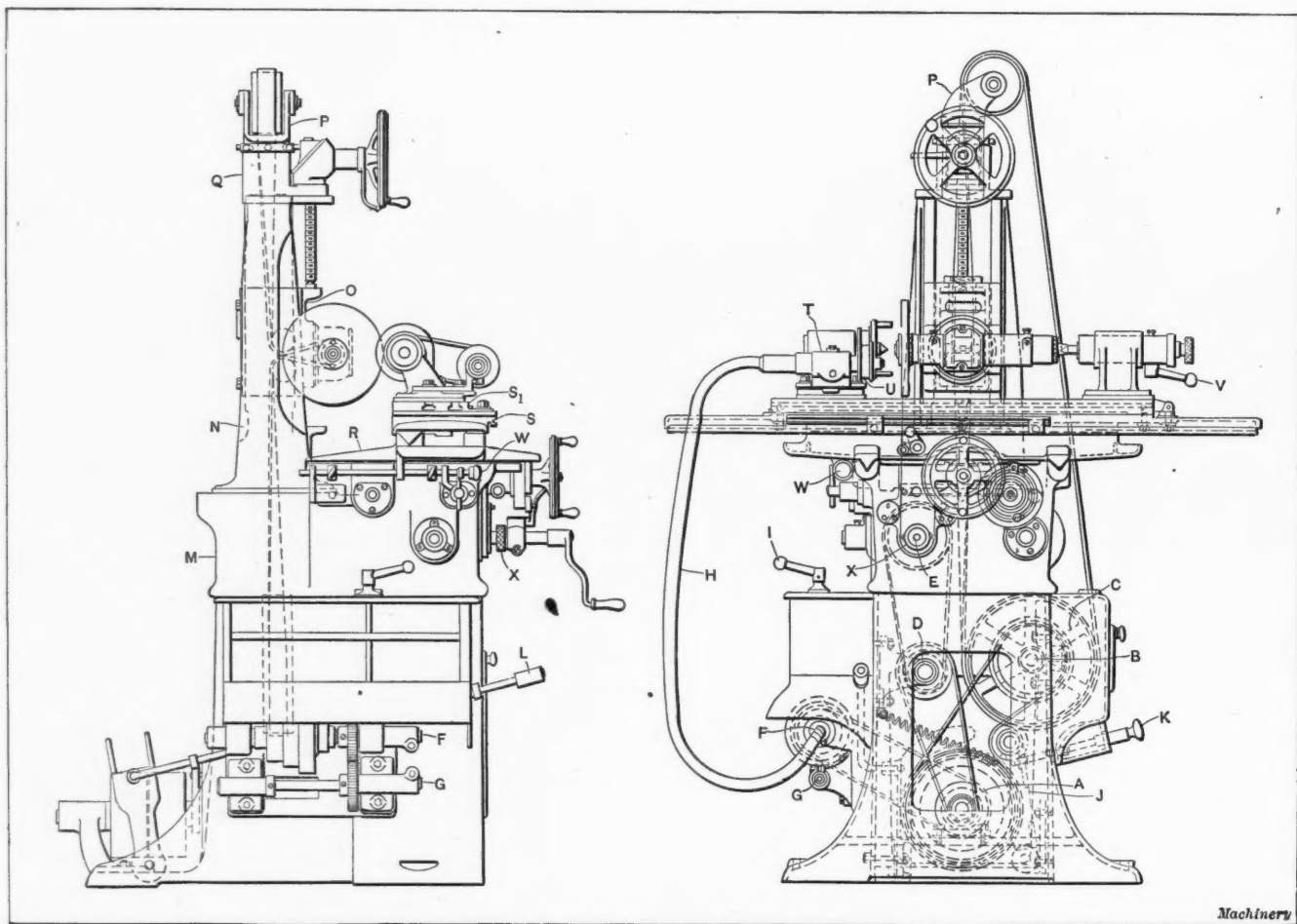
Figs. 4 and 5. End and Front Elevations of Walker Tool-room Grinder

screw adjustment. Upon the headstock, there is mounted an adjustable bracket T, which carries the pulley that connects with the upper end of the flexible shaft. This bracket is held

sirable when, for instance, the machine is set up for face grinding, as illustrated in Fig. 3. In this case, both the chuck-spindle and the flexible-shaft bearing have been reversed.

The tailstock spindle is provided with an adjustable spring to allow for any expansion of the work.

This grinder is not arranged for wet grinding but sectional shields or guards are provided for the top of the platen to take care of the dust. These shields are shown in position in Fig. 1, which illustrates the machine set up for a cylindrical grinding operation. The machine is equipped with an automatic stop mechanism located at the left side of the carriage as shown in Figs. 4 and 5. The knob W is attached to a horizontal rod carrying adjustable collars, which can be set to disengage the automatic cross-feed at any desired point. An instantaneous hand stop is also provided. The hand stop is operated by knob X, conveniently placed at the front of the machine, as shown in Fig. 5.

The diagrams in Fig. 6 show the course of the spindle driv-

The idler pulley G is much wider than idler D, so that the belt, when leaving the spindle pulley, finds its own position. It has been found that with this construction, the grinding spindle can, if necessary, be run at a vertical angle of 45 degrees without any distortion. Figs. 2 and 7 illustrate the advantages of the vertical spindle adjustment. Fig. 2 shows the operation of grinding a milling cutter, and Fig. 7 illustrates an application of the tilting head to the grinding of the beveled edge of a machine part.

Fig. 3 shows the method of driving the machine with an electric motor. The latter is mounted on a bracket rigidly attached to the machine base, and the tension of the grinding belt is maintained by a spring-actuated idler. Fig. 8 shows the machine arranged for grinding the beveled seat of gasoline engine poppet valves. The swivel platen is set at an angle of
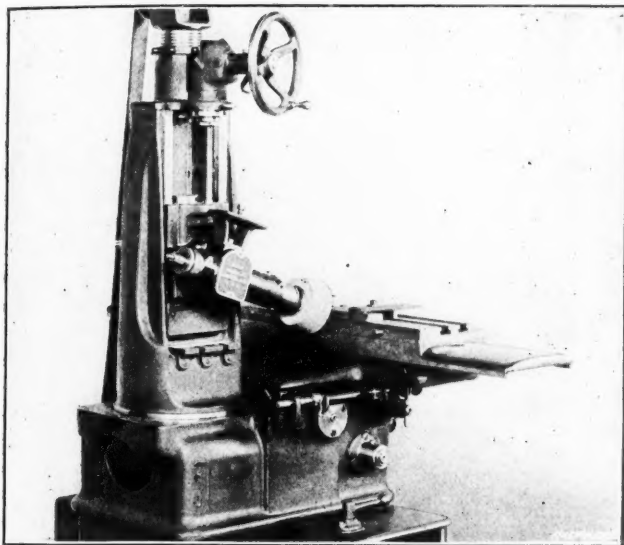
Fig. 7. Example of Work illustrating Use of Tilting Head
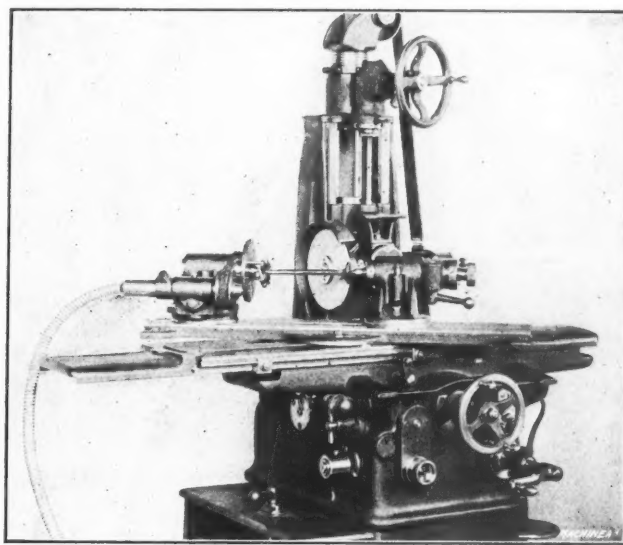
Fig. 8. Grinding Poppet Valves
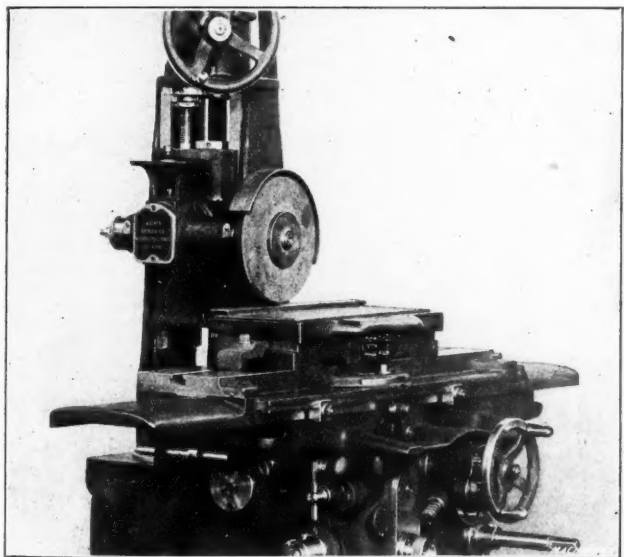
Fig. 9. Surface Grinding—Spindle provided with Extension
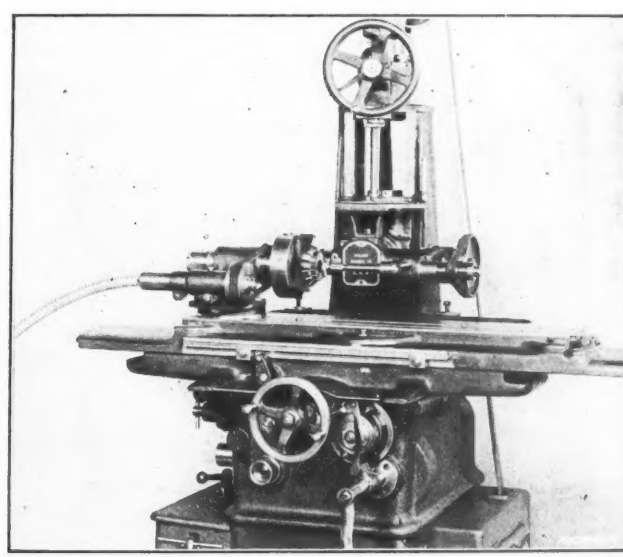
Fig. 10. Example of Internal Grinding

ing belt for various positions of the grinder head. It will be noted that the pulleys B and C always remain in the same position, and that the various adjustments affect only the vertical side of the belt. The belt idler D is mounted in a swivel bracket E, which is held in place by nut F, and can swivel when the grinding spindle is tilted in a vertical plane. This swiveling action is largely automatic and the various positions are indicated by the diagrams. It will be seen that the part of the belt passing through the idler bracket is vertical, and only one side of the belt is affected by the swiveling action. The belt simply runs in a twist above and below the spindle when it is swiveled in a vertical plane. Bracket E turns so that the belt leads in the proper direction towards the periphery of the grinding-spindle pulley, thus obviating the tendency of the belt to crowd on the flanges that would develop if the bracket were not swiveled.

45 degrees, in which position it could not be operated by an overhead drum, but is readily driven by the flexible shaft. At first thought, it might seem that this flexible shaft would cause vibration of the work, but this has not proved to be the case. Any vibration in the shaft itself is not transmitted to the work, on account of the belt connection. Moreover, the overhang of all parts of the machine has been reduced to a minimum so that the construction is very rigid and the grinding smooth and even.

Fig. 9 shows the machine arranged for surface grinding. An extension to the spindle is provided for work of this kind. Another application of the machine is illustrated in Fig. 10, which shows the internal attachment in use. This grinder is, of course, applicable to a very large range of work, and on account of its rigidity, has proved efficient for all the different operations within its range.

BEAMAN & SMITH FOUR-SPINDLE MILLING MACHINE

The Beaman & Smith Co., Providence, R. I., has developed an improved design of four-spindle milling machine. One of the advantages of this machine is the independent control of the spindles, it being possible to operate the spindles singly or in unison. The vertical spindles can be run at
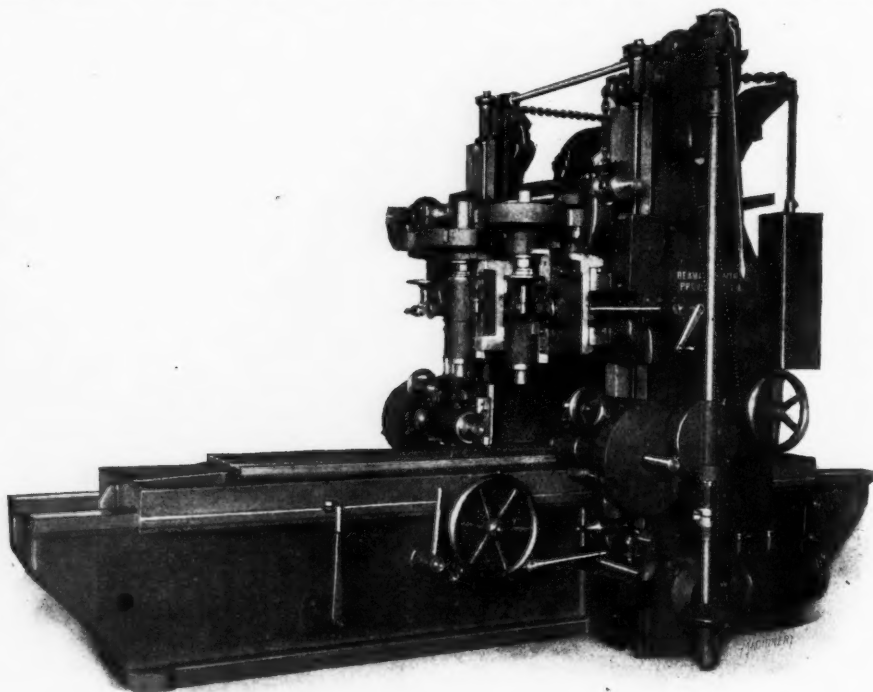

Beaman & Smith Four-spindle Milling Machine

twice the speed of the horizontal spindles and *vice versa*. Provision is also made for reversing the spindles, and there is a second feed-box which gives a reverse feeding movement to the table when the spindles are reversed, thus making it possible to feed the work to the cutters from either direction.

The general construction of this improved design is clearly shown by the accompanying illustration. There are two horizontal spindles carried by the uprights or housings, and two vertical spindles on the cross-rail. The table is of the square-lock construction with one side gib and two under gibs, which provide means of compensating for wear. The automatic feeds can be varied independently of the spindle speeds,

direction and are obtained through a geared feed-box. There are nine changes varying from 2 to 12 inches for any spindle speed. As previously mentioned, there is a second feed-box, the gearing of which is so arranged that feeds can be reversed when the rotation of the spindles is reversed.

The spindles are of crucible steel and run in phosphor-bronze boxes. The front bearings are 4 inches in diameter and 6 inches long, and the rear bearings, 3⅝ inches in diameter and 4¾ inches long. Both the front and rear bearings are tapered and means are provided for taking up wear. The speeds vary from 6½ to 50 revolutions per minute. The ends of the spindles are made to fit cutters according to specifications.

This machine can be arranged for either a belt or motor drive. When a motor is used, one capable of developing 15 H. P. is employed. The cross-rail is raised or lowered by power, and it also has a hand adjustment. The spindles have a 6-inch independent longitudinal adjustment, effected by the handwheels shown, by means of worm gearing and a rack-and-pinion movement.

The centers of the vertical spindles are 6 inches in advance of those on the uprights. The minimum distance from the ends of the vertical spindles to the top of the table is 1 inch, and the maximum 30 inches, whereas the minimum and maximum distances between the centers of the vertical spindles are 12 and 30 inches, respectively. The horizontal spindles have a minimum distance between the ends of 18 inches, and they can be adjusted longitudinally to give an opening of 30 inches. The minimum height from the top of the table to the center of the horizontal spindle is 1 inch, and the maximum height, 26 inches. The weight of this machine is approximately 28,000 pounds.

STANDARD PORTABLE ELECTRIC DRILLS AND GRINDERS

The Standard Electric Tool Co., Cincinnati, Ohio, is placing on the market a line of high-power electric tools. One of the portable electric drills is shown in Fig. 1. This machine
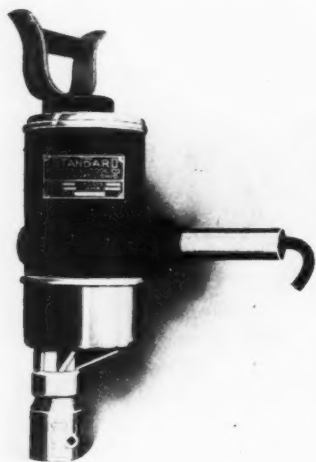

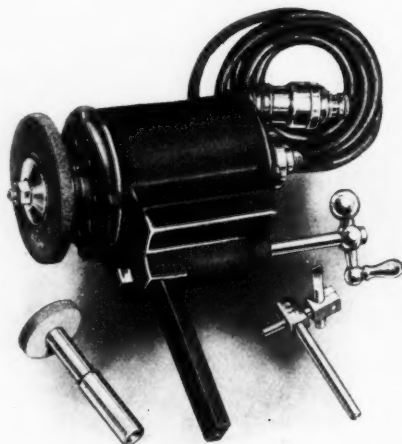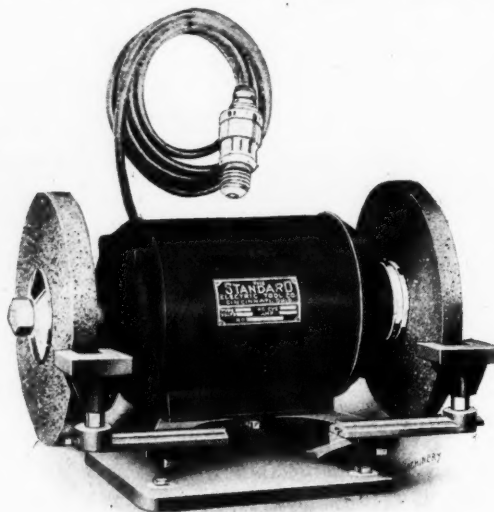Fig. 1. Portable Electric Drill   Fig. 2. Grinder with Toolpost Attachment   Fig. 3. Grinder shown in Fig. 2 converted into Bench Grinder

and there is a quick power movement in either direction ranging from 7 to 14 feet per minute. The table has a working surface 30 inches wide and 10 feet long and a movement of 11 feet on the bed. There are five T-slots for the reception of clamping bolts and two rows of holes for stop-pins.

The automatic feeds to the table are positive in either

has ball bearings throughout and the bearings are dust-proof. The gears are generated from chrome-nickel steel, case-hardened, and are mounted on ball bearings packed in grease. The motors have a strong series winding which gives an excess of power over the rated capacity, thus preventing overloads and "burn-outs." The mechanical construction is high grade

throughout. The drills are built in ¾- and ½-inch sizes for direct or alternating current. The ½-inch direct-current drill is guaranteed to ream metal up to a thickness of 7/16 inch. This company also manufactures a universal drill of ¾-inch capacity that will operate on either direct or alternating current.

The grinders are made for toolpost and bench work. The toolpost or center grinder, illustrated in Fig. 2, can be converted into a bench machine by removing the dovetail slide and placing the motor on top of a suitable base having a corresponding dovetail groove, as shown in Fig. 3. This feature greatly increases the range and utility of the tool.

All motors in both drills and grinders have forced ventilation by means of fans of a special design. The armatures and poles in both drills and grinders, are made of the best soft electrical sheet steel and are uniformly insulated. The grinders are equipped with ball bearings, when specified, instead of adjustable phosphor-bronze bearings.

ROCKFORD UNIVERSAL MILLING MACHINE

The universal milling machine illustrated in the accompanying halftone Fig 1 is manufactured by the Rockford Milling Machine Co., Rockford, Ill. This new machine is known as the No. 2 size. The table has a working surface of 38 by 9 inches, an automatic longitudinal travel of 25 inches, an
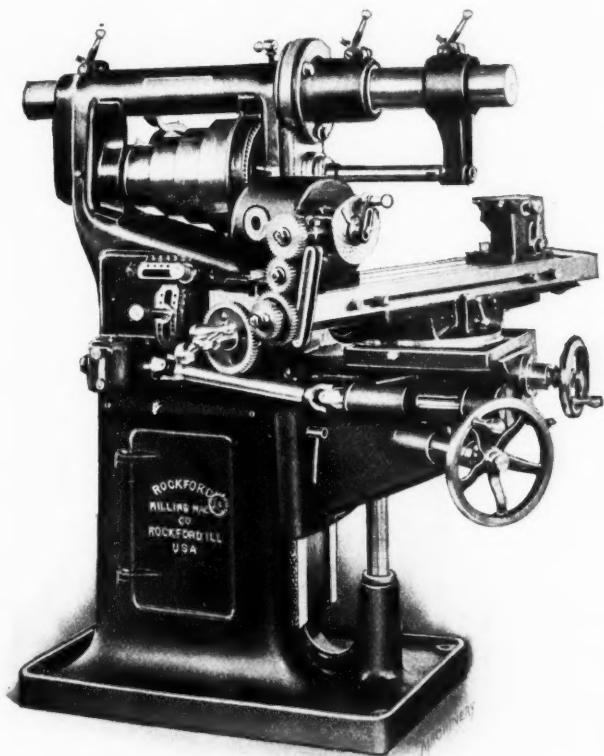
Fig. 1. Rockford No. 2 Universal Milling Machine

automatic transverse travel of 7½ inches, and a vertical power movement of 18 inches. The feeds are all positively driven through gearing and 14 changes are available. The levers for changing and reversing the feeds are conveniently located on the left side of the column, as shown in the illustration. The gears in the feed-box are cut from machine steel and the bearings are of bronze. The automatic feeds can be changed or reversed while the machine is in motion.

The main spindle of the machine has taper journals which run in bearings fitted with felt oil retainers. The wear of the spindle bearings can be quickly taken up by means of a nut at the rear of the spindle. The overhanging arm is equipped with a flanged support which reduces vibration and increases the cutting capacity. The knee has an extended top and an extra long bearing on the column, and the telescopic elevating screw is fitted with ball thrusts. The handwheels

for the cross and vertical feeds are fitted with disengaging clutches.

Sixteen spindle speeds are available (with a two-speed countershaft) which range from 22 to 309 revolutions per minute. The equipment includes a two-speed countershaft, a swivel vise, an arbor, a flanged support for the overhanging arm, a dividing head and center-rest, a universal chuck, the necessary change gears, index plates, wrenches, etc.

The new dividing head is illustrated in Fig. 2. This head has been designed to combine rigidity and accuracy with simplicity and convenience. The worm-wheel, which is securely keyed to the spindle inside the head-block between the front and rear spindle bearings, has a diameter of 5⅝ inches on a 10½-inch head. The worm runs in oil, and there is an eccentric adjusting screw on the outside to take up wear
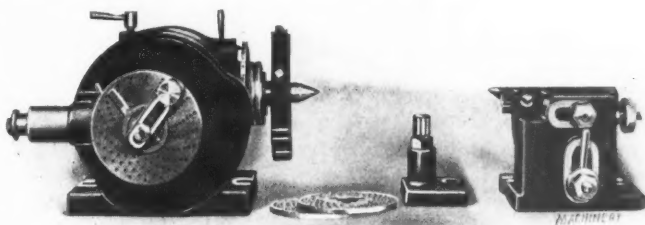

Fig. 2. Universal Dividing Head and Tailstock

between the worm and wheel. The worm can easily be disengaged from the worm-wheel for rapid indexing.

Three index plates are regularly furnished, providing standard divisions up to 380. The spindle has adjustable taper bearings and is provided with a powerful and simple locking device. The front end has a No. 10 B & S taper hole and the nose is threaded to receive a chuck. The taper hole and threaded nose correspond in size to the main spindle so that tools can be interchanged. The swivel block carrying the spindle, swings from a position 10 degrees below the horizontal to 10 degrees beyond the perpendicular.

The center of the tailstock is held at an angle in order to locate the center close to the rear side and top, thus permitting the use of large end-milling cutters for squaring shafts, etc. The center is easily and quickly adjusted and is elevated for milling tapers by a cam. Ten change gears are supplied for spiral milling, and the worm is driven direct from the change-gear shaft.

CAMPBELL SELF-LOCKING COTTER-PIN

A. C. Campbell of Waterbury, Conn., has placed on the market an ingenious form of cotter-pin designed to replace the well-known spring cotter. This new cotter-pin is easily inserted in a hole and can be locked by simply hitting the
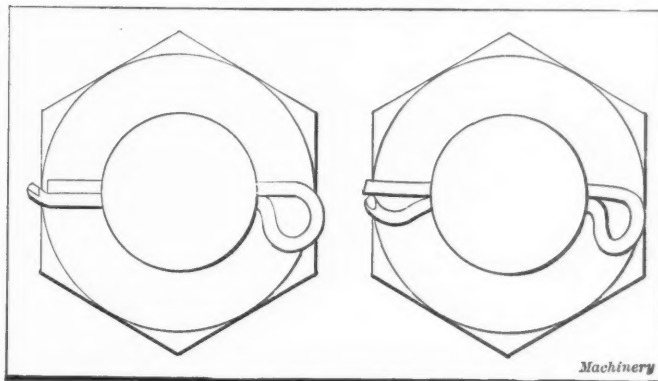
Campbell Self-locking Cotter-pin before and after Locking

loop or eye with a hammer; it is also removed easily. The cotter is made of half-round stock, the same as the ordinary type, but it is bent to a different shape. The eye is offset instead of being central, and the two limbs forming the body of the pin are of unequal length, as will be seen by referring to the left-hand view in the accompanying illustration. The long half of the pin is bent at an angle across the tip of the short member, in order to form a lock for the pin. This

bent end also forms what is practically a conical point, which makes it easy to enter the pin in a hole.

The method of using this pin is indicated by the illustration, which shows its application to a nut and bolt. The pin is placed in the hole as far as the head or eye will permit, as shown to the left, and then the head is flattened to about half its original height by striking it with a hammer. This forces the straight half of the pin farther into the hole which causes the bent end to be pushed downward, as shown by the view to the right. When the ends are forced apart in this way, the pin is securely locked so that it cannot work out of the hole.

This pin is not only easily inserted, but quickly and easily removed by the use of a common screw-driver, the tang of a file, or any tool having a thin, flat point which can be inserted in the loop or eye. After the point of the tool is inserted, it is twisted in the proper direction to draw back the straight half of the pin to its original position. This releases the bent or locking end and the pin can readily be withdrawn with the fingers. These pins can be inserted, locked and removed from the same side, so that they can be used in places quite difficult of access.

DIFFERENTIAL RECORDING GAGE

The Industrial Instrument Co., Foxboro, Mass., is now manufacturing a new differential recording gage which is illustrated in Fig. 1. This gage can be used for recording the differences between pressures, and it is also adapted for recording the flow of fluids by means of venturi or pitot tubes. The moving element consists of a patented pressure-
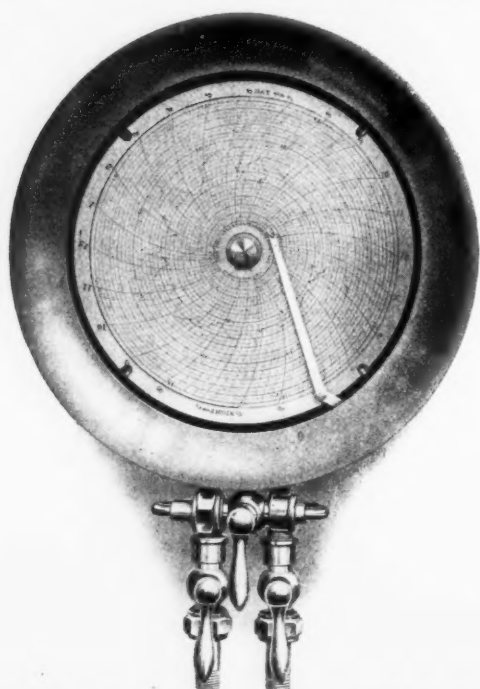

Fig. 1. Differential Recording Gage made by Industrial Instrument Co.

tube movement, which, for pressures below 10 pounds per square inch, is similar to the diaphragm tube shown in Fig. 2; whereas, for differential pressures exceeding 10 pounds per square inch, the helical tube movement shown in Fig. 3, is used.

The pen arm is attached directly to the shaft in both of these movements, which gives a rigid support. A friction joint in line with the shaft, makes adjustment possible without affecting the length of the pen arm. A pressure tube is employed having a range sufficient to cover the differential pressure desired. One of the two pressures, the difference between which is to be recorded, is applied internally to the pressure tube, and the other externally, the principle being the same as in ordinary practice except that one pressure, instead of being atmospheric, is replaced by some other pressure. Transmission from the movement to the pen arm is obtained by means of a special bearing passing through the wall of the chamber enclosing the movement.

This gage can be employed to advantage for recording the height of water in a boiler. When so used it is applied to the water column and gives a record not only of the height of the water, but an accurate record of the time the water column or gage glass is blown, the time the boiler blows off, or of any other disturbance affecting the height of the

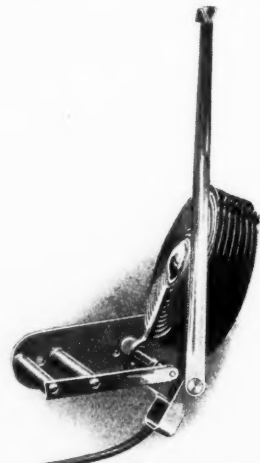Fig. 2. Diaphragm Tube Movement   Fig. 3. Helical Tube Movement

water in the gage glass. This continuous record will result in keeping a more uniform water level and will be an efficient check against unsafe high or low water, thus insuring greater economy and safety. The recorder can be placed at a distance from the boiler, if so desired, so that in case of an explosion, the responsibility can be placed where it belongs.

SHADOWLESS DRAFTING TABLE

The drafting table shown in the accompanying illustration has a plate-glass top beneath which is an illuminating chamber containing three electric lights. Among the advantages claimed for this construction are, the elimination of shadows and a good light regardless of the position of the windows or the time of day. The light can be intensified to any desired degree and it can also be subdued, either by the addition of tissue sheets or by reducing the electric lamp power.

The illumination from beneath makes it possible to easily trace from blueprints or drawings of any kind. Tracings can

Ulrich Shadowless Drafting Table

also be made on stiff drawing paper or bristol board, by intensifying the light, as may be required. The glass top has a cork pine frame to which the drawings may be attached with either ordinary thumb-tacks or a special suction clamp furnished with the table. The construction of the table is such that the angular position or height can be quickly adjusted, and it is rigidly held in position.

By adjusting a ventilator beneath the drawing board, the warmth from the electric lamps under the plate-glass top, can be so regulated that the ink will dry as rapidly as it is applied, thus making it possible to work over these lines immediately. There is a shelf on the left side of the table and a cabinet on the opposite side, which are very convenient for holding drawing instruments and other equipment. This table is manufactured in five different sizes by Eugene Dietzgen Co., 166 W. Monroe St., Chicago, Ill.

BARDONS & OLIVER CUTTING-OFF MACHINE

The cutting-off machine shown herewith is a 6-inch size built by Bardons & Oliver, Cleveland, Ohio. This is an exceptionally heavy and compact machine designed for rapid and efficient operation. The spindle speeds vary from 20 to 152 revolutions per minute with 10 per cent speed increments. The changes are obtained by means of a geared head and a Westinghouse 15-horsepower, adjustable-speed motor having a variation of from 300 to 1200 revolutions per minute. The motor is regulated by a drum controller having 16 points. This wide range of speeds makes it possible to use the most economical cutting speed.

The time required for inserting and removing the stock has been reduced to a minimum by means of the automatic chuck, the adjustable stop and the drum controller. The cutting-off tool-slides are so designed that all interference from chips is avoided. The support for these slides is fastened to the front of the head which has an extension on the side, as the illustration shows. This support or bracket has openings between the slide and head, thus allowing the chips to fall directly into the pan without interfering with the operation of the slides. This construction also permits shortening the main bed. There is an open space to the right of the cutting-off tool-slide which makes it convenient to remove the chips. An ample supply of oil for the cutting tools is furnished by a suitable pump, and there is a pan to catch the lubricant.

The motor is attached to the left-hand end of the machine

is 6⅜ inches, whereas the hole through the spindle is 7 1/16 inches. The front spindle bearing has a diameter of 9¼ inches and is 8 inches long. The rear bearing has a diameter of 8⅝ inches and a length of 6¾ inches. The cutting tools measure ⅜ x 2½ inches. The weight of the machine, including the motor, is about 16,000 pounds.

BESLY PATTERNMAKERS' DISK GRINDER AND DRUM SANDER

The patternmakers' combination disk grinder and drum sander shown in Fig. 1 is manufactured by Charles H. Besly & Co., Chicago, Ill. All gear guards have been removed in order to show the arrangement of the driving mechanism. The machine is driven by a 3 horsepower motor mounted on
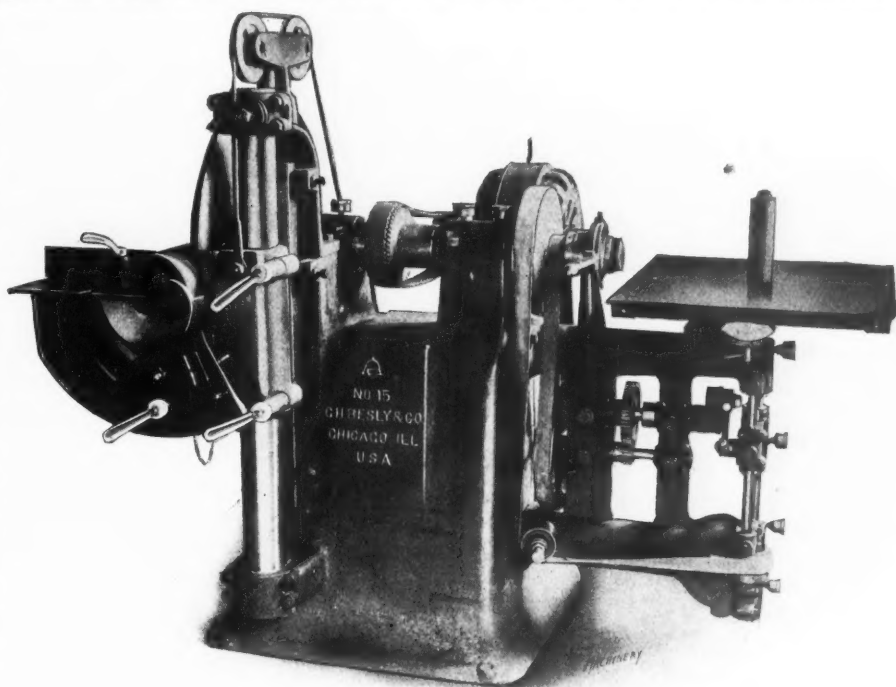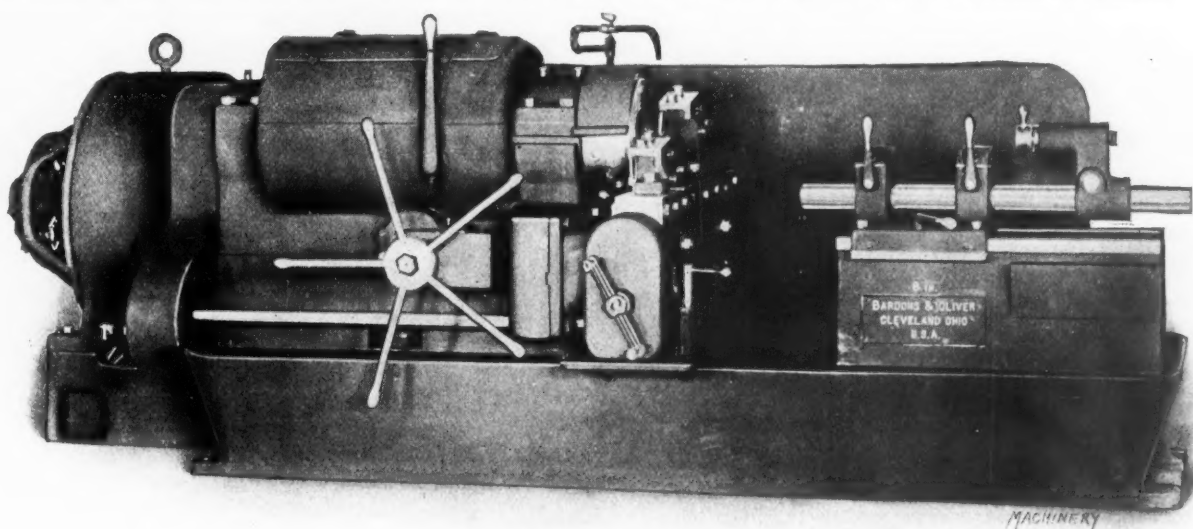

Fig. 1. Besly Combination Disk Grinder and Drum Sander for Wood Patternmaking

a bracket bolted to the rear of the bed. This motor connects with the main spindle through sprockets and a Link-Belt silent chain.

The steel disk wheel is 30 inches in diameter, ¾ inch thick and runs at a speed of 750 revolutions per minute. The work-

Bardons & Oliver Six-inch Cutting-off Machine

and forms an integral part of the construction, so that the machine is an independent unit which can be placed in the most advantageous position. The automatic chuck has a capacity of 6 inches, and the hole through the chuck plunger

table for the disk wheel is 14 inches wide and 40 inches long. and can be tilted and locked at any angle from 75 degrees to 135 degrees from the plane of the grinding disk. Large distinct graduations are provided to indicate the angular position.

The work-table is so arranged that the inside or working edge remains within 1/32 inch of the grinding disk, regardless of the angular position, and the supporting mechanism is back of the disk wheel and below the face of the work-table, so that there are no obstructions to interfere with the work. The work-table has a vertical adjustment of 25 inches and is supported by a round vertical shaft which permits swinging the table away from the grinding disk for convenience when re-setting a wheel or facing off extra large patterns.

The machine is equipped with four work-table attachments which include a sizing circle gage for cylindrical and conical grinding, a sliding bevel gage for simple and compound angle grinding, a sizing bevel gage for simple and compound angle grinding to dimensions, and an angle-plate for the free-hand cornering of thin work. There is a telescoping dust hood which may be piped to an exhauster for withdrawing the grinding dust.

The drum sanding attachment at the right is driven through a Johnson self-oiling friction clutch which enables the oper-
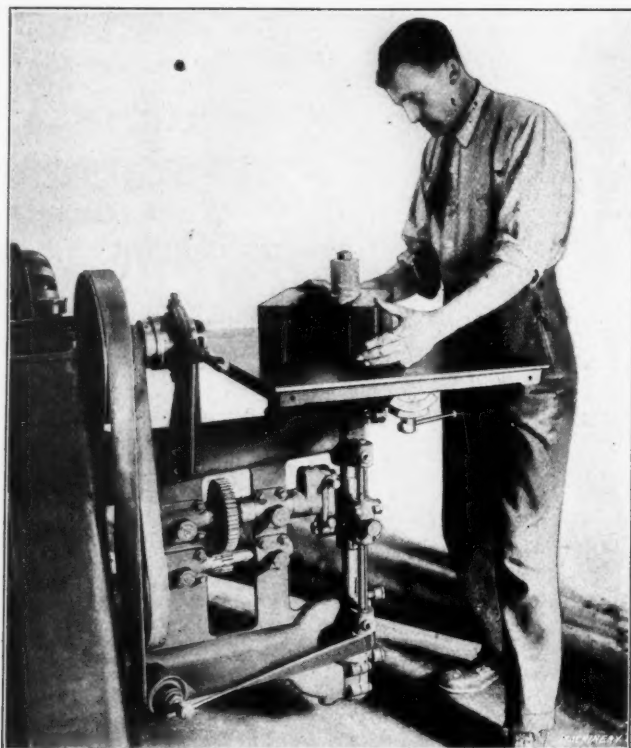
Fig. 2. View illustrating Use of Drum Sanding Attachment

ator to stop the drum sander independently of the disk wheel. This is very essential, as the disk wheel is usually allowed to run continuously, whereas the drum sander must be stopped in order to attach drums of various sizes for different classes of work. The work-table of the drum sanding attachment measures 24 by 28 inches. It can be tilted and locked at any angle from 85 degrees to 105 degrees from the axis of the sand drum, and the position of the table is shown by large graduations which can easily be seen.

The sand drum illustrated is 2½ inches in diameter and 8 inches long, but drums varying from 1 to 6 inches in diameter and of any reasonable length can be used. The work-table has a central annular opening 8½ inches in diameter into which are fitted circular plates with center holes to accommodate drums of different sizes. The sand drum runs at 2250 revolutions per minute and when in operation, it is given a vertical reciprocating movement to equalize the wear of the abrasive. This reciprocating movement is obtained from the crank seen beneath the table, and it is adjustable from 0 to 4 inches. The sand drum spindle is driven by a 2-inch quarter-turn belt, and the reciprocating crank is driven by a 1½-inch belt, which transmits power to the crankshaft through the intermediate shaft and gearing shown.

Fig. 2 illustrates how the sand drum attachment is used for finishing straight and curved inside surfaces. The table is tilted to an angle of 1½ degree, in this particular instance, to give the required draft.

This machine occupies a floor space of 54 by 84 inches and

weighs 2800 pounds. It is made with either 30- or 40-inch disk wheels and for a belt or motor drive.

IMPROVED POLISHING MACHINE

The accompanying illustration shows an improvement which has recently been made on the 12- and 14-inch ring-oiling polishing machine manufactured by the Builders Iron Foundry, Providence, R. I. The loose pulley has a diameter ½ inch less than the diameter of the tight pulley in order to relieve the tension on the driving belt when the spindle
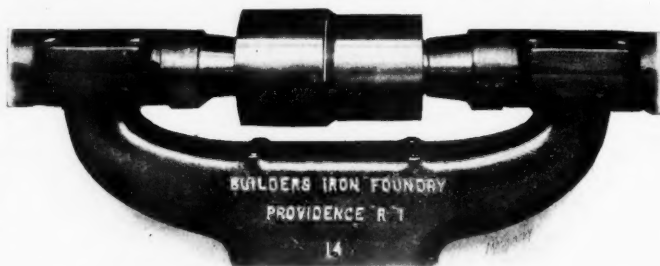

Spindle Mounting and Belt Pulleys of Polishing Machine made by Builders Iron Foundry

is stationary. This well-known feature permits the use of an extra-tight belt without subjecting the loose pulley to excessive strain; consequently there is less wear on both the belt and pulley. The loose pulley has a beveled flange on the tight pulley side, so that the belt can be shifted easily. This polishing machine has a positive method of lubrication which permits it to be run at very high speeds without lubrication troubles.

STEPTOE HAND MILLING MACHINE

The hand milling machine illustrated herewith is of a recent design now being built by the John Steptoe Shaper Co., 2951 Colerain Ave., Cincinnati, Ohio. The table of this machine can be operated either by a lever feed or a screw feed.
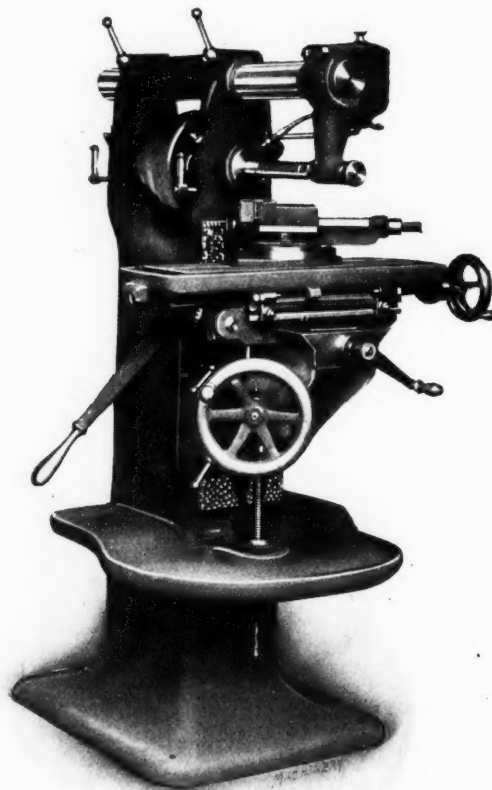
Steptoe Hand Milling Machine

The lever feed is intended for the rapid milling of small parts, but when desirable, either because of accuracy or for some other reason, the screw feed can be employed. This screw feed has a collar accurately graduated to thousandths of an inch.

This machine is also built with a lever elevation for the knee, when so ordered, and it will be manufactured later

with a power feed for the table. The vise has a graduated base for setting it to any angle. The pan seen below the knee prevents chips and oil from falling on the floor, and it is also convenient as a tool rest. The bearings are of high-grade phosphor-bronze and are tapered and threaded on the ends to take up wear. The bearings are thoroughly oiled by means of felt oilers.

DALLETT PNEUMATIC TOOLS FOR PATTERNMAKING

In view of the fact that pneumatic tools have proved so efficient for chipping metals, carving stone, etc., it seems rather strange that they have not come into general use in wood-working establishments. In the pattern shops, for instance,
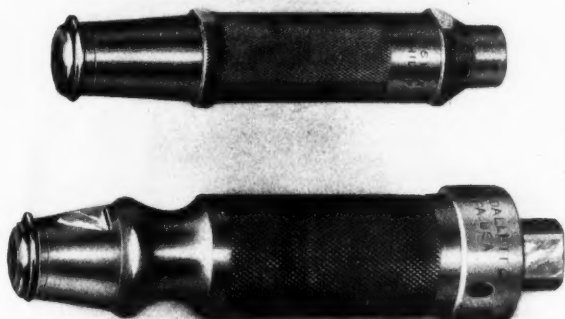
Fig. 1. Dallett Pneumatic Tools for Wood Carving and Patternmaking

there is always more or less hand carving which could doubtless be done easier and quicker with the aid of pneumatic tools. The Thomas H. Dallett Co., York and 23d Sts., Philadelphia, Pa., has placed on the market pneumatic tools for wood carving which are an adaptation of the pneumatic stone-working tools which this company has been manufacturing for years.
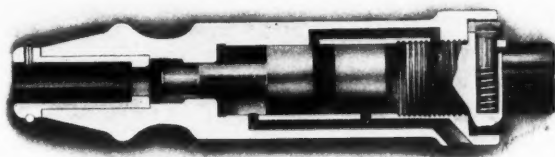

Fig. 2. Sectional View of One-inch Pneumatic Wood-carving Tool

These tools for wood carving are made in two sizes, which are illustrated in Fig. 1. The upper tool is a ¾-inch size intended for fine carving and finishing, whereas the 1-inch size below is more powerful and is adapted for gouging and heavy roughing work.

It is claimed that these tools enable one man to accomplish a great deal more than would be possible by the old method of hand carving. They can be regulated to give a light or hard blow, either by placing the thumb over the exhaust hole or cutting down the air supply by means of a stop-cock in the hose. Both tools are of the valveless type and operate on the same principle, although there is a slight difference in the design. The head of the ¾-inch tool is locked by a pin and spring, whereas, in the 1-inch "finger grip" design, the head is locked by a ratchet and pawl.

The sectional view, Fig. 2, shows the construction of the larger size. The tool-steel piston is the only moving part, and it strikes as high as two or three thousand blows per minute, the rate depending upon the pressure. The cylinder is of hardened steel and, in the case of the "finger grip" design, it is one solid piece. A renewable hardened bushing is inserted in the end of the barrel for the reception

of a shank having a special "quarter-octagon" shape instead of being round. With this arrangement, the chisel can be held steady and secure without any effort on the part of the workman. Furthermore, by having a shank of this shape, the chisel can be twisted when gouging or roughing, in order to split or pry off a chip, which could not be done with a round bushing.

As wood chisels are made with both tang and socket ends, three fittings known as a plug, shank and socket shank are


Fig. 3. Using the Dallett Pneumatic Tool for Patternmaking

furnished to adapt the pneumatic tools for any style of chisel. The shanks are provided with a recess on one side which is engaged by a locking spring to prevent the shank from dropping out when the tool is in operation. This feature makes it unnecessary for the workman to hold the chisel in place.

Fig. 3 illustrates the application of this tool to patternmaking. The air consumption of the ¾-inch size is approximately four cubic feet of free air per minute, and that of the 1-inch size, about five cubic feet.. The air pressure required depends entirely upon the character of the work and the kind of wood being operated upon. The pressures range from 40 to 100 pounds, but pressures between 70 and 90 pounds are most commonly used for general work.

SCHUCHARDT & SCHUTTE VERNIER CALIPER

Schuchardt & Schutte, Cedar & West Sts., New York, has placed on the market the improved form of vernier caliper shown herewith. This is a combination tool which can be used for measuring inside and outside diameters and also as a depth gage. The extension jaws seen above the regular caliper jaws, are used for internal measurements, and the depth gage slides in a groove on the rear side and projects
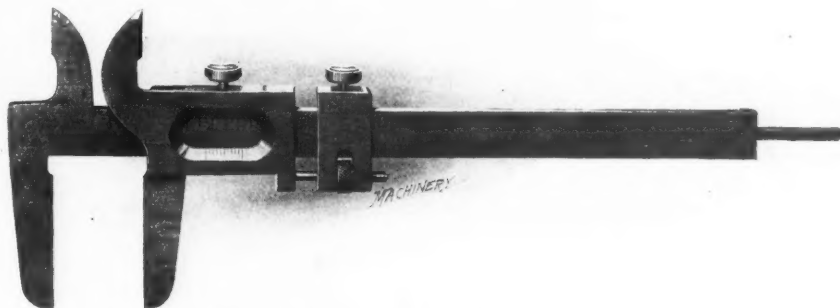
Combination Vernier Caliper for Inside, Outside and Depth Measurements

beyond the end of the bar or scale, as shown to the right. The jaws and depth gage move together, so that all three measurements are obtained at one setting, and the scales give a direct reading.

The general arrangement of this caliper is similar to the type formerly sold by this company, but the construction is

quite different. The fixed jaws for internal and external measurements are integral with the bar instead of being riveted in place, and the sliding jaw completely encircles the bar, instead of being retained by a flat spring, as with the older design. This construction makes the tool much stronger and adapts it for hard usage in machine shops.

The bar is 6 inches long and is graduated on the upper and lower edges. Two sets of graduations can be furnished. The upper and lower scales of one set are graduated to sixteenths and twenty-fifths of an inch with verniers reading to one-hundred twenty-eighths and one thousandths inch, respectively. The other set has one-sixteenth-inch graduations on the upper scale and millimeters on the lower scale with verniers reading to one-hundred twenty-eighths inch and one-tenth millimeter, respectively.

BATH GRINDING MACHINE FOR MULTIPLE KEY-SHAFTS

The grinding machine illustrated herewith has been designed for grinding integral multiple key-shafts or sliding-gear shafts for automobile transmission cases. A formed grinding wheel is used and the sides of two keys as well as the circular surface between them, are ground simultaneously. This machine is built by the Bath Grinder Co., Fitchburg, Mass. Fig. 1 is a front view showing the water guards in place; Fig. 2 is an end view illustrating the construction and arrangement of the grinding wheel head; and Fig. 3 shows a key-shaft in place and the wheel in position for grinding. Before taking this latter view, the water guards were removed to expose the details of the machine.

The vertical column has two wide bearing surfaces upon which the grinding wheel head is mounted. The column is strongly ribbed internally and firmly bolted to the base of the machine. The wheel-head is rigidly constructed and careful attention has been paid to the oiling system. The wheel-spindle is made of tool steel, hardened and ground, and runs in

plunger-bolt is released by a slight backward movement of the handle shown; then by a forward movement, the work is revolved and the plunger-bolt engaged in the next taper notch. This mechanism is so designed that the dial cannot revolve backwards when free of the plunger, which insures a positive indexing action. The number of divisions on the dial are determined by the number of keys in the shaft to be ground.
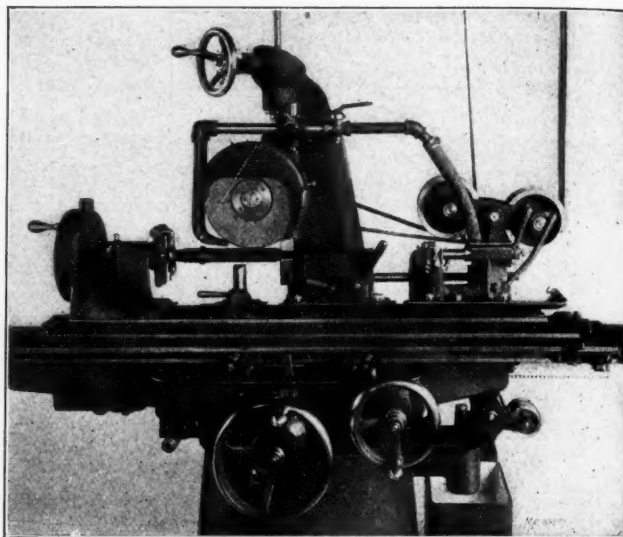

Fig. 3. View of Bath Grinder with Water Guards removed

The footstock furnished on this machine is very compact and rigid in construction. The center carrier is flat and is set into the base at an angle, thus bringing the center within one-half inch of the top and one-half inch of the inner side of the footstock. This allows the grinding wheel to pass the footstock, without disturbing its position. The center carrier is operated by a spring controlled by the lever seen at the right-hand end of the footstock. The carrier may be locked firmly in position
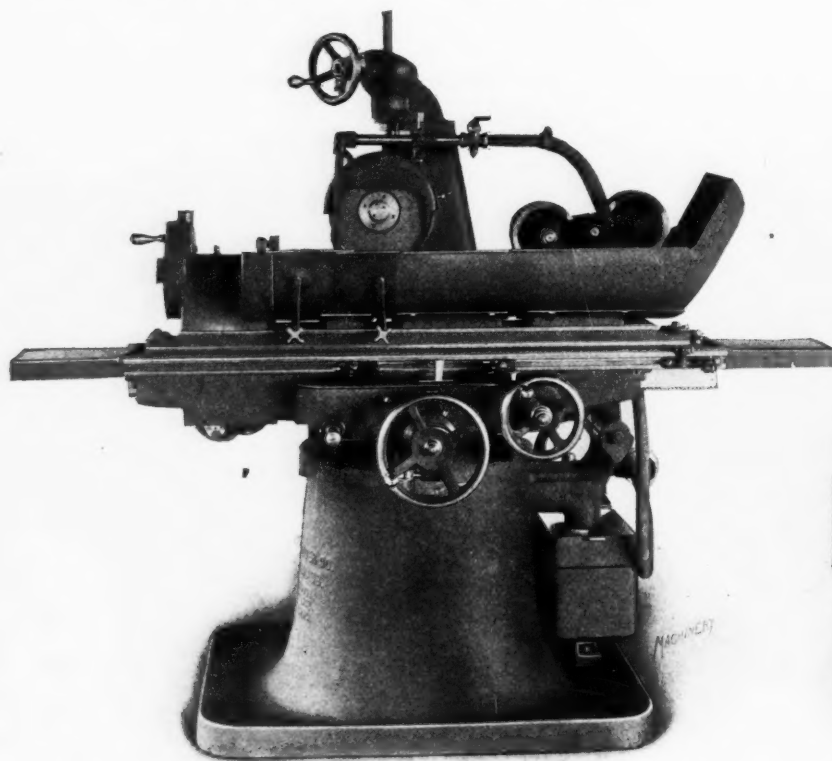

Fig. 1. Bath Multiple Key-shaft Grinding Machine

Fig. 2. End View of Bath Grinding Machine

adjustable phosphor-bronze bearings, which are thoroughly protected from grit. The handwheel for feeding the grinding wheel vertically, is graduated to read to 0.00025 inch, and it is equipped with a stop for grinding duplicate parts. The thrust of the vertical feed screw is taken by ball thrust bearings.

The machine is provided with an indexing work-head, firmly bolted to the table. The indexing mechanism consists of an index dial, a tooth ratchet wheel and an index plunger-bolt, all of which are protected from water and grit. The index
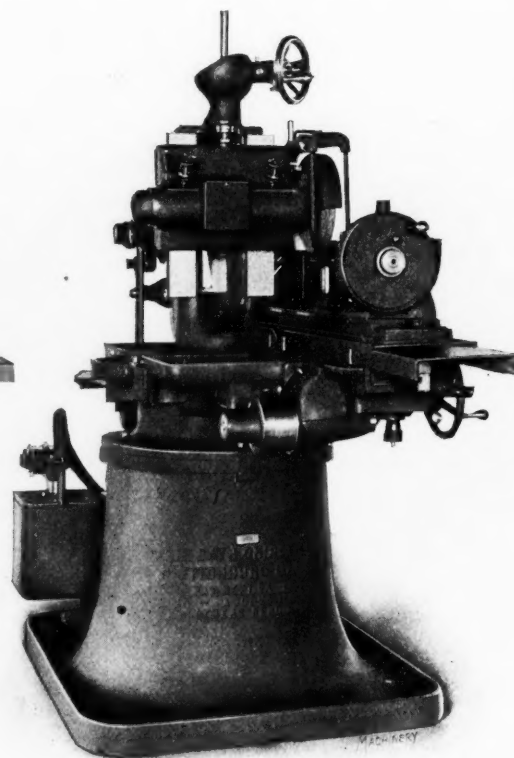
by the handle at the left. All operating parts are thoroughly protected from water and grit.

The wheel truing device, which is illustrated in Fig. 4, is provided with three black diamonds. One is for forming the radius of the wheel and is operated by the short lever seen at the end of the fixture. The other two diamonds are for forming the sides of the wheel and are operated simultaneously by the long lever shown at the end of the fixture. The diamond for forming the radius is carried by a steel spindle which

revolves in a taper bearing, and is provided with a very sensitive adjustment. The alignment of the side forming diamonds is insured by adjustable taper keys. These bearings are carefully protected from grit and water.

After this device has been properly located at the back of the footstock, it should not be disturbed. When truing the grinding wheel, the table is moved so as to bring the center of the grinding wheel over the center of the diamonds, the

Fig. 4. Device for Truing Sides of Wheel and Forming Radius

table being provided with a twin stop for locating it in the correct position. The master block for setting the diamonds is clamped on top of the wheel truing device base, which is provided with a dovetail to insure alignment. The master block carries a hardened tool steel plug, to which the diamonds are set. A shield is furnished to cover the bearing on the wheel truing device when the master block is not in use.

A combination centering and rest base is furnished for centering work rapidly, and also for supporting slender work. This fixture is clamped to the table and is provided with a plunger, the top of which is formed to fit between two keys on the shaft to be ground. The plunger is actuated by a spring, and is controlled by a lever which has a cam cast integral and
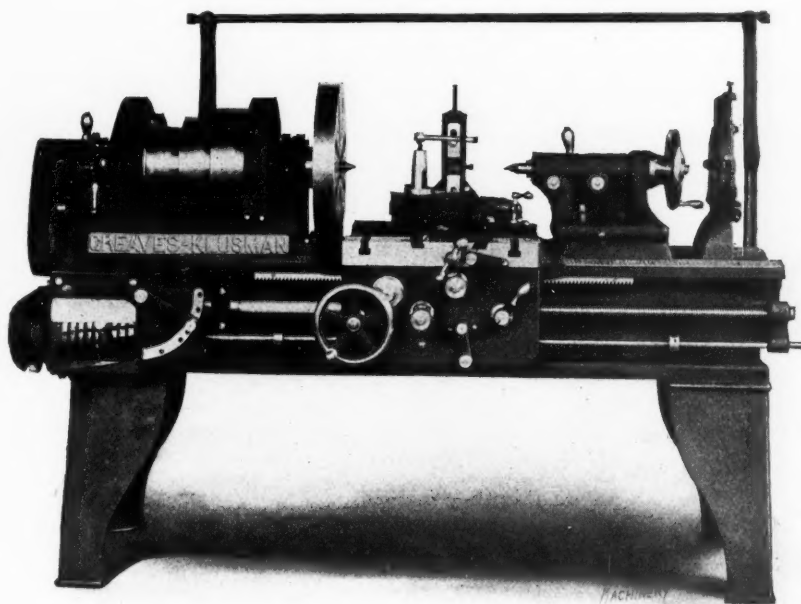
Greaves-Klusman Quick-change 17-inch Engine Lathe

engages the plunger. A slight turn of this lever to the left relieves the plunger, and, when used as a support, the plunger may be clamped firmly in position by moving the lever in the opposite direction.

The table is controlled in the usual manner by adjustable dogs operating against a reversing lever which actuate a clutch of the "load-and-fire" type. The table can also be controlled by a hand-reversing lever, which provides means for auto-

matically stopping it at the end of its traverse, by simply giving the lever part of a turn at any time during the traverse of the table. All operating levers, handles and adjustments are within easy reach of the operator from the front of the machine. The water tank is separate from the machine, thus making it convenient for cleaning.

ROBERTSON POWER HACKSAW

In the June, 1912, number of MACHINERY a power hacksaw, known as No. 2, manufactured by the W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y., was illustrated and described. The accompanying illustration shows a larger size of hacksaw, known as No. 5, built by the same company. This machine is designed for cutting off structural shapes and solid stock, round or square, the maximum capacity being 8 by 15 inches. The saw frame is adjustable and allows the use
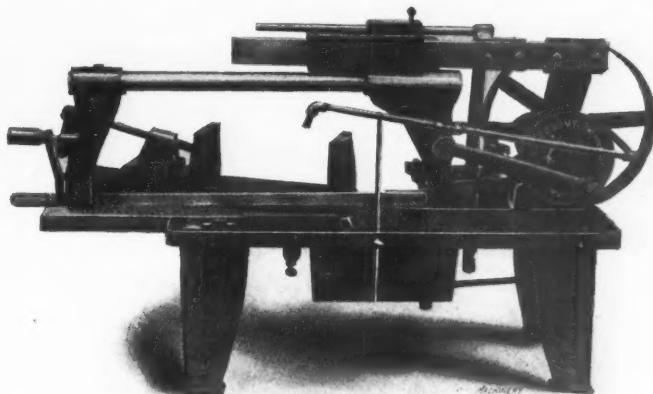
"Economy" Power Hacksaw

of a 10-inch blade for cutting small stock, which involves a great saving when large stock is not being cut continually. The vise has strong wide jaws and is provided with a quick adjustment so that the operator can open or close it instantly to take stock from 1 to 15 inches. The vise swivels to a 45-degree angle, and is graduated.

The saw cuts on the draw stroke, and is raised on the return stroke by an arrangement which is very simple mechanically, yet positive and durable. The saw stops automatically when the cut is completed. The tank shown under the bed is for cooling liquid, which is pumped to the blade by a rotary pump connected to the driving gear at the rear of the head.

The maximum length of the blade is 24 inches, the minimum being 10 inches; the stroke is 6 inches. The driving pulley speed is 140 R. P. M., and the net weight of the machine is 360 pounds.

GREAVES-KLUSMAN 17-INCH LATHE

Greaves, Klusman & Co., Cincinnati, Ohio, have added to their line of lathes, a 17-inch quick change-gear type having a three-step cone and friction double back-gears. The bed is a new form designed to minimize twisting strains by means of heavy reinforcements under the V's, which extend below the top of the girths. The headstock is massive and the spindle is made of high-carbon steel and runs in self-oiling phosphor-bronze bearings. The front spindle bearing is hardened and ground in position. The self-adjusting, friction, double back-gears can be engaged by the operator in any position along the bed, by simply shifting the horizontal bar shown.

With the two-speed, friction countershaft regularly furnished with this lathe, eighteen speeds are obtainable. As six of these speeds are secured without shifting the belt, it is convenient to obtain the proper speed for roughing and finishing.

The frictions of the double back-gear mechanism are of simple construction and have two rings which engage recesses in the gears. There are two toggles fitted in each ring which expand the frictions when the longitudinal bar is shifted. These frictions are self-adjusting for wear and have ample strength to transmit the maximum belt pull.

The tailstock has an extra-long spindle which is gripped by two sets of double-plug clamps at both ends of the barrel. This clamping device is operated by a single handle. The carriage has a full length bearing on each V and a flat bearing inside the front V, which shortens the bridge and gives a direct support under the tool-rest. The apron is the double-plate box form. The quick-change gear-box at the left is a simple, compact design having but two handles which control the entire range of threads and feeds. The lathe is fitted with a chasing dial for "catching" threads, and all threads from two to fifty-six per inch can be cut, including the 11½ pipe thread. There is a clutch for independently engaging or disengaging the lead-screw on the feed-rod. This clutch is operated by a hand-wheel on the gear-box.

This lathe has a swing over the bed of 18⅝ inches, a swing over the carriage of 13⅛ inches, and it takes 31 inches between the centers, with a 6-foot bed. The front spindle bearing is 3 3/16 inches in diameter and 5⅛ inches long, and the rear bearing is 2⅝ inches in diameter and 4 5/16 inches long. The back-gear ratios are 3.5 to 1 and 12 to 1.

BLISS TOGGLE DRAWING PRESS

The accompanying illustrations show the front and rear views of a toggle drawing press recently designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This is said to be one of the largest drawing presses of this type ever built. This press is intended for drawing and forming sheet metal automobile parts made of thick stock, such as brake drums,
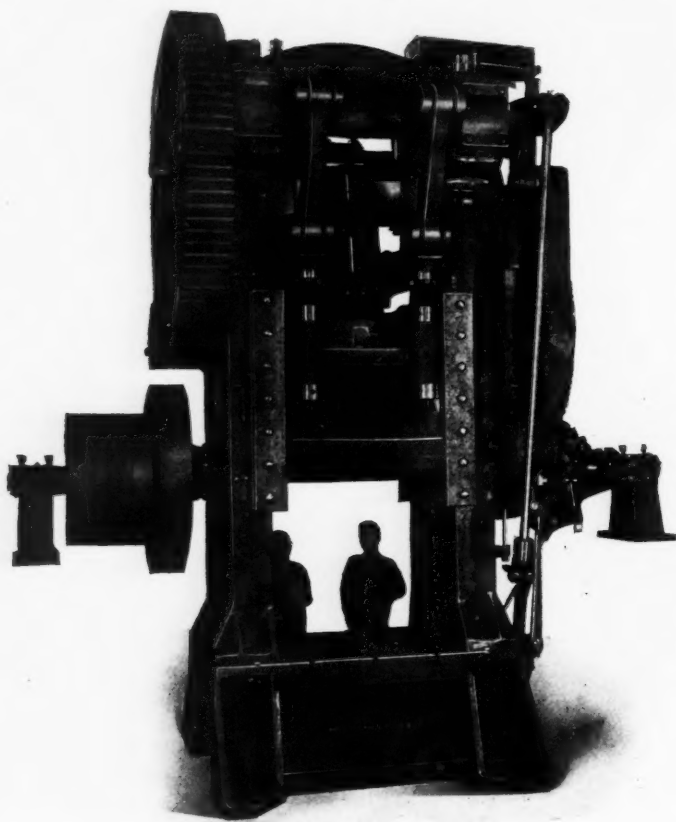

Fig. 1. Large Toggle Drawing Press built by E. W. Bliss Co.

rear axle housings, etc., but it is equally well adapted for other lines of manufacture in which very heavy stock is drawn.

The construction is of the built-up type, the bed, the crown-piece and uprights being separate and bound together by four 7-inch steel tie-rods, which take all the working strain. These tie-rods are heated and shrunk into place. The frame columns are of cored box section, and impart great rigidity to the entire structure. The main crankshaft is 12 inches in diameter

and has a stroke of 24 inches. The stroke of the blankholder slide is 16 inches.

The entire construction of the machine is in proportion to the 12-inch crankshaft and 7-inch tie-rods, and the calculations were based on the bending strength. With a factor of safety of 2½, the machine has a safe working capacity of 600 tons. Attention is called to the basis of the calculations, because in many instances, the capacity of presses is figured on the shearing strain. If the latter method were adopted in this case the press shown would have a capacity of 1000 tons, but to have this capacity with the bending strength taken as a basis, would require 9-inch tie-rods and a 16-inch crankshaft.

The Bliss toggle movement is applied to the press and all pressure on the blank is transferred through straightened
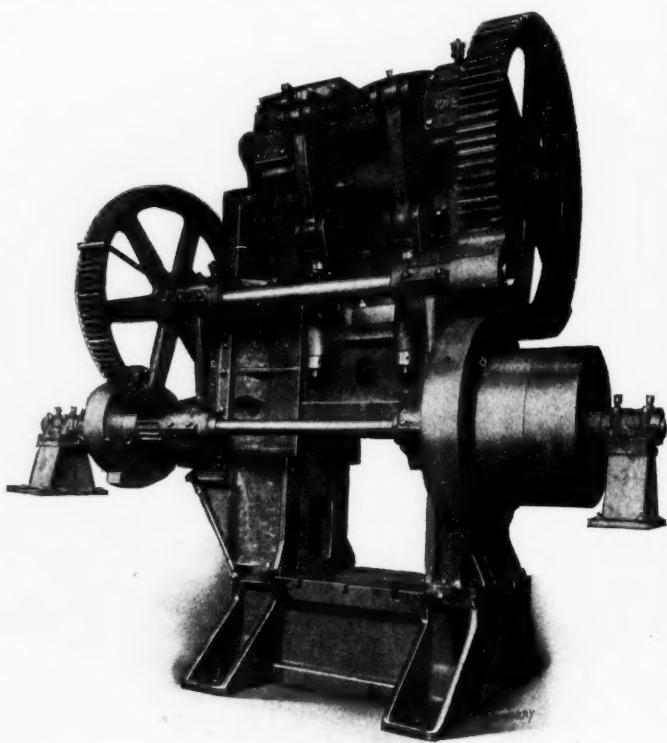

Fig. 2. Rear View of Bliss Toggle Press

toggles directly to the frame, relieving the bearings from all friction and wear due to blank-holding, with a consequent reduction in power consumption.

The press is double geared, and the entire train of gears are of steel castings, and machine cut. The press is controlled by a powerful hand-actuated friction clutch of the double-grip type, the action of which is practically instantaneous. This clutch, in connection with the semi-automatic brake, places the movements of the press entirely under the control of the operator, so that it can be started or stopped at any point. It will be noted that the bottom of the outboard bearing standards are very high from the base of the press. This arrangement was necessary because of the low ceilings in the building at the place of installation, which requires the press to be placed in a pit of considerable depth. The actual shipping weight is 170,000 pounds.

NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., has recently designed a heavy type of horizontal milling machine for forge work. The bed of this machine is of an extra-heavy, double-ribbed, box-type construction having oil pans cast integral and bearings with square gibs for the table. The sides of the bed are fitted with tongues for attaching the uprights which extend to the floor line. The work-table is also exceptionally heavy, of double-ribbed box-type construction, and has an angular steel rack bolted to the bottom which is engaged by a bronze worm-gear of steep lead and large diameter.

The rail is of the inclined face type and is of large propor-

tions. It is fitted to the uprights with square lock bearings. Adjustments are made by taper shoes, and the alignment is maintained by the narrow guide bearing on the left-hand upright. The bearing of the rail on this upright, for alignment, is on both sides of one shear, to prevent any distortion of the bearing surfaces. The bearing for the driving worm-wheel sleeve and the driving worm are cast solid with the rail, which gives a strong resistance to thrust and tends to eliminate chatter.

The spindle revolves in a bronze bushed capped bearing, which has a hand side adjustment on the rail for convenience in setting cutters. The rail is of sufficient length to permit removing the cutters without taking off the outer support. The spindle is arranged to drive the cutter arbor by means of a broad face key, and the arbor is held in place by a through retaining bolt. The outer end of the cutter arbor is supported in bushings that have parallel internal and taper external bearings, fitted with adjusting nuts to compensate for wear. Individual screws fitted with micrometer measuring collars

Newton Horizontal Milling Machine for Forge Work

are furnished for moving both the horizontal spindle and the vertical spindle saddles. The outer support is adjusted rapidly by means of a rack and pinion. The cross-rail elevating screws have a top and bottom bearing, and as the counterweights are heavier than the rail, tension is always maintained and lost motion eliminated.

placed beside the worm-wheel for the horizontal spindle. The motion is transmitted through a clutch so that the vertical spindle can be disengaged when not needed.

This machine has a reversing fast power traverse, positive geared feeds with nine changes, and a reversing fast power elevation for the cross-rail, in addition to hand adjustment for the table and rail. One handwheel controls the hand movement of the rail and table, and the lever controlling the direction of the rapid traverse for the table always controls the movement of the cross-rail.

The diameter of the horizontal spindle is 6⅜ inches; side adjustment of the spindle by hand, 12 inches; distance from the center of the spindle to the under side of the cross-rail, 4 inches; independent hand adjustment of the vertical spindle, 9 inches; width of work-table on the working surface, 42 inches; length that can be milled, 12 feet; width between the uprights, 48 inches; maximum distance from the center of the spindle to the top of the work-table, 52 inches.

This machine is driven by a General Electric 50–60-horse-power, shunt motor with a speed range of from 400 to 1200 revolutions per minute.

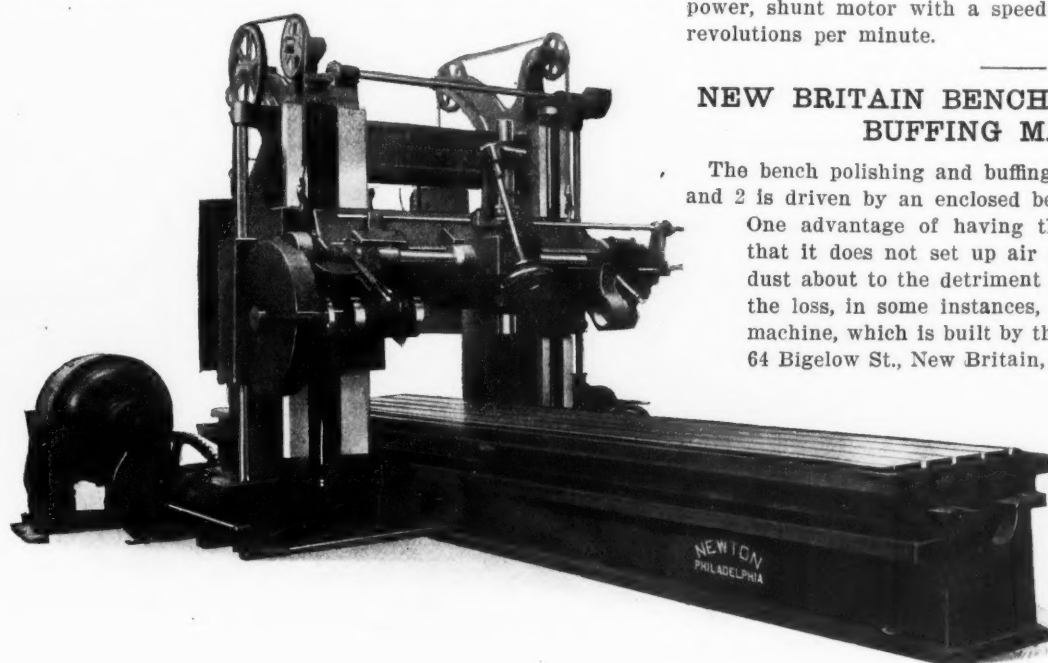## NEW BRITAIN BENCH POLISHING AND BUFFING MACHINE

The bench polishing and buffing machine shown in Figs. 1 and 2 is driven by an enclosed belt from beneath the bench. One advantage of having the driving belt enclosed is that it does not set up air currents which would carry dust about to the detriment of the worker's health, and the loss, in some instances, of valuable material. This machine, which is built by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has been designed to facilitate cleaning, there being plain, smooth surfaces with rounded corners, so that all valuable material that is polished and buffed off can be recovered.

The drive from beneath keeps the spindle down in the bearings, which is said to give a smoother running head than when the pull of the belt holds the spindle against the box cap. The drive from beneath also makes possible a simple means of starting and stopping without any loose pulleys. This is accomplished by swiveling the upper portion of the head which is hinged at the rear and is held by a toggle lever. When the head is lifted by pushing the lever down, as in Fig. 1, the belt is tightened and the spindle set in motion.
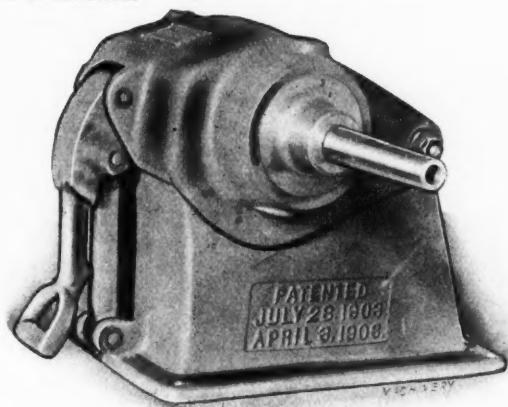

Fig. 1. The New Britain Bench Polishing Machine

As many forgings, such as large driving shafts, require feather keyways, this machine has been equipped with a vertical spindle to mill the ends of the keyways. The vertical spindle is five inches in diameter, and is arranged to drive the cutters by a broad face key. It is fitted with a No. 6 Morse taper, retaining and drift key slots, and a micrometer measuring shoulder. The vertical spindle is driven from a spur gear

Fig. 2. Starting Toggle raised to disengage Belt from Driving Pulley

On the other hand, when the lever is raised, as in Fig. 2, the spindle is dropped onto a brake-block which stops it quickly, and the belt sags away from the driving pulley beneath the bench. The toggle lever is so designed that as the belt tightens, the leverage increases, and, at the end of its downward movement, the toggle becomes self-locking.

The machine is equipped with either a double- or single-end

spindle. The boxes are self-aligning and have a ball section in the center which allows the bearings to adjust themselves, if the shaft is sprung either by heavy belt pull or excessive polishing pressure on the end of the spindle. The spindle is oiled by solid internal collars which dip into the oil and carry it up to the strippers above, which distribute it to each end of the bearings. This collar also serves to take up end motion.

GORTON HEAVY-DUTY CUTTING-OFF MACHINE

The accompanying illustrations show a 16-inch heavy-duty, high-speed cutting-off machine recently built by the George
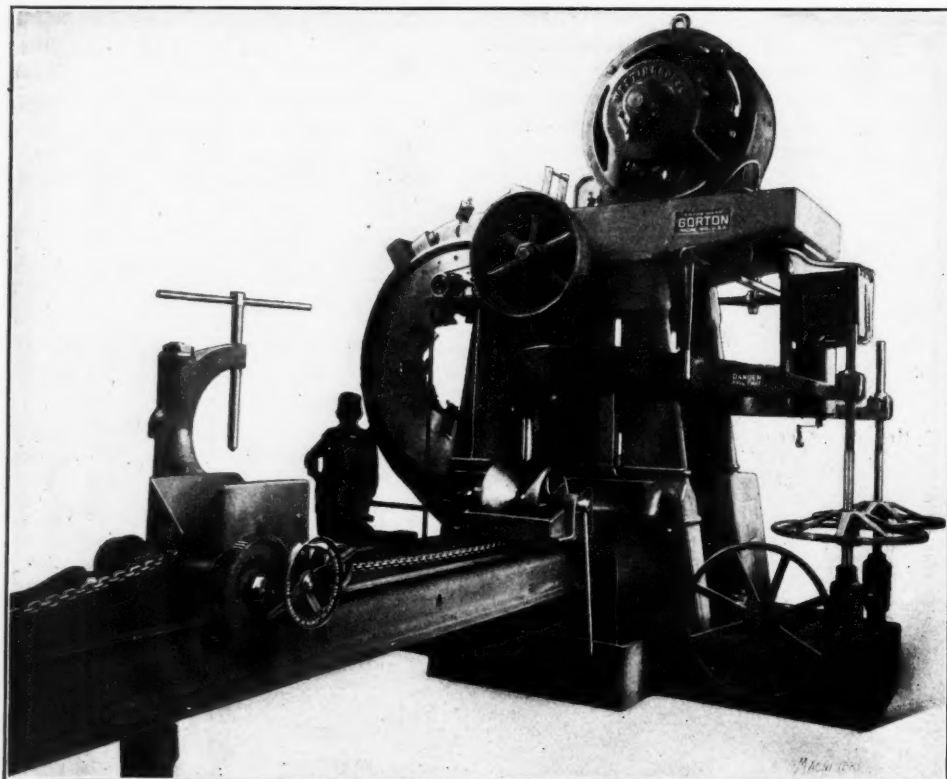

Fig. 1. Gorton Sixteen-inch Cutting-off Machine with Drum raised to provide Access to Cutters

Gorton Machine Co., Racine, Wis. This machine has been under development by the Gorton company during a period of several years, the various details being covered by numerous

in diameter, in thirty seconds, and 12-inch bar can be cut off in one minute; but the working speed recommended is one minute for a 6-inch bar of the material mentioned, other sizes being operated upon in the same proportion.

The machine is driven by a 40 H. P. variable-speed motor. The main driving gear is 72 inches in diameter with a 4½-inch face, and is made of semi-steel. It meshes with a main driving pinion, integral with its shaft, made of a crucible steel forging. The diameter of the pinion is 5 inches, and as the cutter points are 10 inches from the center of rotation of the saw drum, this arrangement makes an exceedingly powerful drive. The outside clutch gear, shown in Fig. 3, is 36 inches in diameter and is driven directly from the motor through an intermediate gear as indicated. The cutter travel can be varied from 17 feet per minute up to 51 feet per minute, according to the kind of stock being cut. The cutter blade is ¾ inch thick, and the opening between the cutter points is 20 inches in diameter. To avoid accidental breakage of cutters, the main clutch is provided with a shearing pin which will release the driving mechanism when undue strain is placed upon the cutter. This shearing pin is so located that the cutter is disconnected from all parts of large diameter which continue to revolve until the motor is shut down. This arrangement avoids any flywheel effect which would tend to continue to rotate the cutter after the shearing of the pin.

The stock is fed through the machine by means of a stock carriage, as indicated in Fig. 2. The amount of stock fed may be measured off accurately by means of a measuring bolt. The stock severed is forced on through the V-block at the rear of the machine, indicated in Fig. 3. Simple and powerful clamping arrangements are provided. These may be operated either by hand, or by hydraulic or pneumatic means.

An important feature of this machine, as well as of other
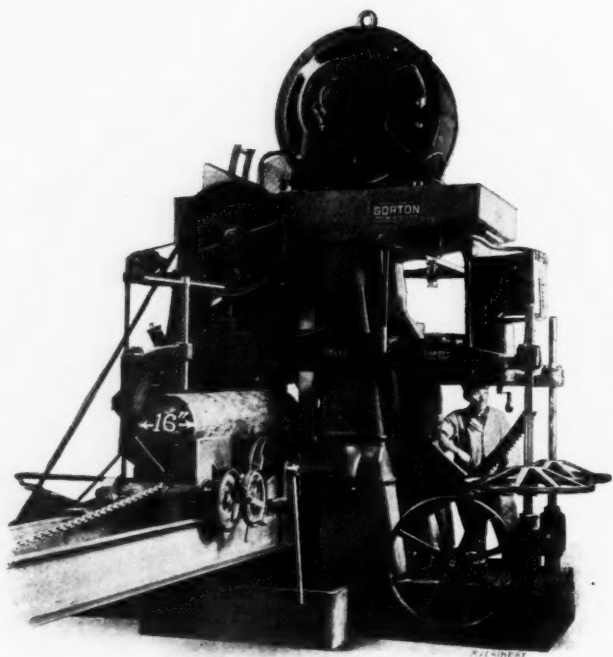
Fig. 2. Cutting-off Machine with Bar in Place ready for Cut

Fig. 3. Rear View of Gorton Cutting-off Machine

patents both in the United States and abroad. The special feature of the machine is its great capacity; it will sever round, 30 to 40 point carbon open hearth steel bars, 6 inches
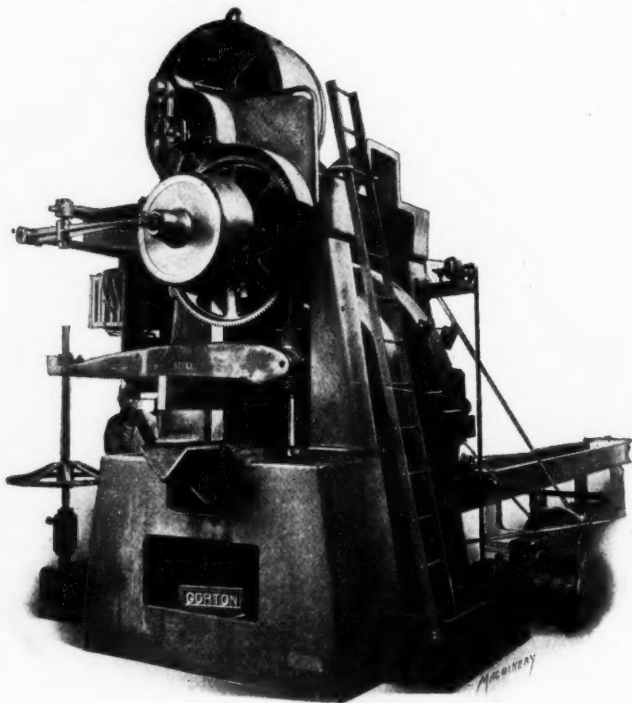
Gorton cutting-off machines, is that the cutter blade with its drum is driven through spur gearing, as this means of driving is most economical in power consumption, most durable, and

least expensive to manufacture and to maintain. The feed is by means of a worm and worm-gear segment.

The question of lubrication has been given special attention. The saw drum bearings operate in a flood of oil, and the construction is such that it is impossible for the cutting compound, chips or dirt to enter these bearings. The main pinion bearings, which are 3½ inches in diameter, also operate in a flood of oil. The feed work cases are also flooded with oil, and the main driving clutch is partially so lubricated. A pump is provided for flooding the cutters with lubricating compound when in operation.

The total net weight of the machine, as shown in the illustrations, exclusive of the stock rack, is 55,000 pounds. The total height of the machine, including the motor, is 12 feet, the shipping height, with motor removed, being 9 feet 6 inches. The length of the base on the floor line is 9 feet 6 inches, the width being 7 feet.

KELLY AUTOMOBILE HUB REAMERS

The accompanying illustration shows a boring and reaming outfit for automobile wheel hubs made by the Kelly Reamer Co., Cleveland, Ohio, the tools as shown being especially intended for use on the Jones & Lamson turret lathe. The tool shown to the right is the boring tool used for roughing only, while that shown to the left is the finishing reamer. The tools shown at the bottom, between the shanks of the holders, are exchange-tools used for the small end of the hub.

One of the improvements introduced in these tools as compared with the ordinary design of Kelly reamers, illustrated
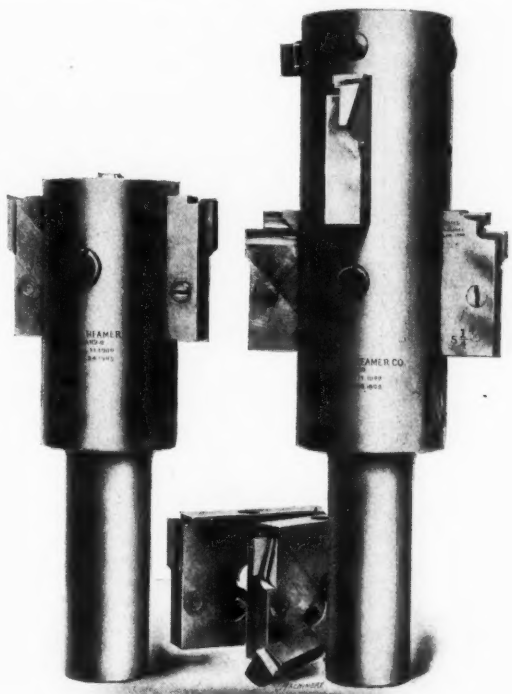
Kelly Roughing and Finishing Reamers for Automobile Wheel Hubs

and described in the July, 1908, number of MACHINERY, is that the reamer blades do not extend outside of the flat reamer holder body in the lengthwise direction. Thus the tools can be easily slid in and out of the holder and rapidly exchanged. This feature is especially valuable for crankcase work, where it is imperative that the boring and reaming be done at one setting of the work, to insure alignment. The special construction then permits the change from boring or roughing reamer bodies to floating finishing reamers to be made rapidly and without difficulty.

TWENTIETH CENTURY BALANCING STAND

The balancing stand shown in the accompanying illustration has been brought out by the Rockford Tool Co., Rockford, Ill., and is designed for balancing pulleys, flywheels, armatures, etc. It will swing wheels 8 feet in diameter, and has a carrying capacity of 5 tons. The distance between the standards

is adjustable, the maximum distance being 8 feet and the minimum distance 2 feet. The adjustment is by means of a rack and pinion, the hand-crank shown in the foreground being used for this purpose.

The size of balancing stand shown in the illustration is known as No. 4. Besides this one, four other sizes are built, known as Nos. 1, 2, 2A and 3. Size No. 1 is intended for bench use and is 20 inches between the standards. It will swing 22 inches, and carry a weight of 1000 pounds. No. 2 and 2A both swing 46 inches and have a distance of 30 inches be-
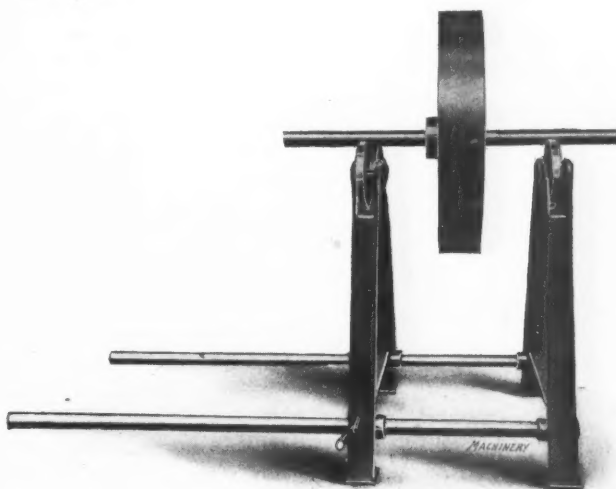
Twentieth Century Balancing Stand, built by the Rockford Tool Co.

tween standards. No. 2 has a carrying capacity of 1000 pounds, while No. 2A will carry one ton. Size No. 3 has a carrying capacity of 2½ tons with a maximum distance of 6 feet between standards, and a swing of 6 feet.

The rotating disks which carry the shaft of the wheel to be balanced run in ball bearings. The disks on stands Nos. 1 and 2 are made from steel, hardened and ground, while the disks on sizes 2A, 3 and 4 are made from chilled cast iron and ground.

ELGIN BENCH TAPPING MACHINE

The Elgin Tool Works, Elgin, Ill., has brought out a new tapping machine of the bench type. The construction of this machine is very simple, as will be seen by referring to the engraving. The two heads which carry the tapping spindle and the work table respectively, are mounted on a vertical column or shaft which can be furnished in different lengths so that holes in the side of a box or frame can be tapped. The tap spindle is driven through a friction clutch interposed between the belt pulleys shown. One of these pulleys carries an open belt, and the other a cross belt for obtaining a reverse movement.

To operate the machine, the work is placed on the table and is lifted up until the tap enters the hole. A stop-collar on the table spindle is set for the required depth, and when this collar comes against the under side of the table bracket, the upward movement is arrested and the tap spindle

Elgin Bench Tapping Machine

is drawn downward, thus disengaging the friction clutch from the upper driving pulley. A slight downward pressure then
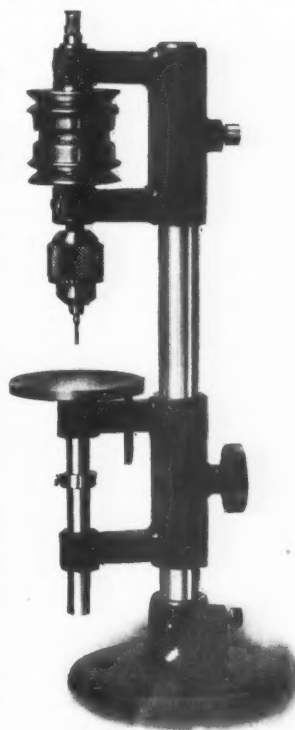
engages the reversing clutch, and the tap is backed out of the hole.

SANDERSON PORTABLE BORING-BAR

The accompanying illustrations show a portable boring-bar for straight and taper holes, which has been brought out by the Sanderson Tool Sales Co., 438-439 Brown-Marx Bldg., Birmingham, Ala. Fig. 1 shows the general appearance of the tool, while the line engraving, Fig. 2, shows the details of the design. The special features of the boring-bar are that it is readily adjusted, easy to operate, and simple in construction; it can be applied to ordinary drill presses, radial drills, lathes, electric or air motors, and in fact to any machine or appliance having a revolving element.

The tool consists, as shown in Fig. 2, mainly of a tool carriage A, a tool bar guide D, and a driving bar I. The tool carriage consists of a rack and worm, and a holder with a graduation segment. The rack holds the cutting tool B which is inserted at right angles to it at the bottom end. The tool is operated by a star feed at C. The rack is guided by the tool bar guide D which is dovetailed so as to hold the rack and tool firmly and prevent the tool from chattering or vibrating. Adjustment for different tapers is easily obtained by loosening the nuts E, F and G. If a straight hole is to be bored, the tool is merely set over by means of the nuts and slots to any diameter within the capacity of the bar.

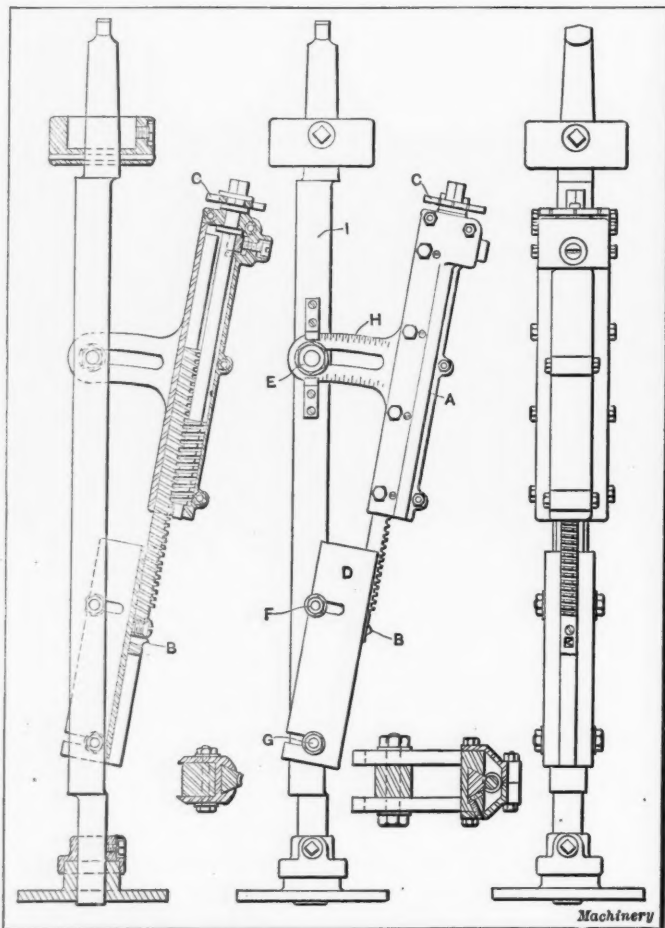

Fig. 1. Sanderson Portable Boring-bar

Fig. 2. General Design of Portable Boring-bar for Straight and Taper Holes

The length over-all of the device is 32 inches. The taper shank fits a No. 4 Morse taper socket. The tool has a capacity for boring holes varying from 2½ to 5 inches in diameter,

straight or taper, to a depth of 8 inches. The taper adjustment allows tapers up to 6 degrees to be bored. Special bars can be made to take care of holes of other dimensions and tapers.

* * *

NEW MACHINERY AND TOOLS NOTES

Knurling Tool: A. B. Campbell, Fairport, N. Y. Hand-operated knurling tool having three knurls. The part to be knurled is placed in a vise and the tool, which is turned like a die, feeds itself along the surface of the work.

Die-head: Pottstown Machine Co., Pottstown, Pa. Die-head having a machinery steel body and four chasers which are securely held in internal slots, the angle of which conforms to Briggs standard pipe tapers. These heads are made in several sizes having capacities from 1 to 6 inches.

Radial Drilling Machine: Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. Plain radial drilling machine of an improved design. This machine is equipped either with a cone drive, speed-box drive, variable-speed motor drive, or a motor and speed-box drive. All gearing is enclosed and the construction throughout is along modern lines.

Sensitive Drill Press: Francis Reed Co., Worcester, Mass. Sensitive drilling machine which is provided with six spindle speeds. Three speeds are obtained from cone pulleys and this number is doubled by shifting the position of the quarter-turn idler at the top of the column. This idler is controlled by a lever and is automatically locked in position.

Electric Welders: Geuder, Paeschke & Frey Co., Milwaukee, Wis. Automatic electric spot-welders made in four sizes, ranging from 10 to 50 kilowatts capacity. The machine is set in motion by a foot pedal, and all welding operations are entirely automatic. The capacity is from 100 to 200 welds per minute when operating on sheets of from 19 to 31 gage thickness.

Tap Grinder: Wells Bros. Co., Greenfield, Mass. Machine for grinding taps correctly. The tap to be ground is held between centers and it is kept in the proper position by an adjustable spring-finger which regulates the clearance. The grinding is done by a cup wheel. The machine has a self-contained countershaft, and will take taps up to 12 inches in length.

Bench Lathe Attachments: Elgin Tool Works, Elgin, Ill. Auxiliary equipment for the bench lathe, including a filing attachment, two milling attachments and cylindrical and surface grinding attachments. One of the milling attachments has a horizontal spindle carried upon a vertical slide, and the other a vertical spindle which can be set in any desired position.

Turret Lathes: Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathes of recent design, known as Nos. 2A and 3A machines, respectively. The 2A size has a capacity for bar stock up to 2¼ inches in diameter and, with a chucking outfit, will take castings or forgings 12 inches in diameter. The 3A machine has a capacity for bar stock up to 3¼ inches in diameter and for chuck work up to 15 inches.

Drilling, Boring and Milling Machine: Detrick & Harvey Machine Co., Baltimore, Md. Heavy drilling, boring and milling machine of the horizontal type, having a box-shaped runway on which a large vertical column is mounted. The latter has a traverse of 168 inches and the saddle a vertical movement of 144 inches. Power for traversing the column and saddle is obtained from a 7½-horsepower motor, and the spindle is driven by a 20-horsepower motor.

Drilling Machine Vise: Easton Tool & Machine Co., Easton, Pa. Vise for use on table of drilling machine. The front jaw has a travel of 3½ inches and the rear jaw can be turned to present different sides to the clamping or front jaw. One side of the rear jaw corresponds to the clamping jaw; another side serves as an angle-plate, and the two remaining sides are provided with V-grooves for holding cylindrical work, one groove being vertical and the other horizontal.

Bevel Gear Shaper: Browning Engineering Co., Cleveland, Ohio. Automatic bevel gear shaper having a revolving templet which gives the proper shape to the teeth, so that epicycloidal, involute or any special form of tooth can be cut by providing the proper templet. Twenty-five templets are supplied with the machine. When the shaper is in operation two tools plane opposite sides of the same tooth, alternately, and a gear is finished complete in one revolution of the blank.

Automatic Bevel Gear Shaper: Fred Mill, 622 William Ave., Detroit, Mich. When this shaper is in operation, cuts are taken from first one tooth and then the next, and so on around the blank. The arbor bearing is then moved on its horizontal axis to give a new depth of cut, and the teeth are planed successively as before. This operation is repeated until the teeth are formed to the required depth. The tool is relieved on the backward stroke and all movements are automatic.

Spring Coiling Machine: F. H. Sleeper, 12 Shafner St., Worcester, Mass. Universal coil-making machine which will

coil and cut springs of various shapes, and has a capacity for diameters varying from ¼ to 2 inches. The wire enters the machine between rolls and it is pushed through guides to the coiling and cutting-off mechanism. The rolls have two grooves for receiving either large or small stock. On the main shaft of the machine there are three cams; one of these varies the diameter of the coil, another gives the pitch or opening between the coils, and the third is for cutting off. The output of this machine varies from 35 to 100 springs per minute.

Inverted Spindle Drilling Machines: Foote-Burt Co., Cleveland, Ohio. One machine is a special design for drilling oil holes ¼ inch in diameter and 8 inches long. It is a 4-spindle inverted type, the spindles projecting through the table and the work being held in the upper heads. When drilling, the heads are fed downward either by hand or power. This company has also built two other machines of the inverted type, each of which has six spindles. One is designed for machining 6-cylinder automobile engine castings, and the other is for drilling long oil holes in cast-iron belt conveyor brackets. One of the advantages of this inverted construction is the absence of overhang and the ease with which chips may be disposed of.

* * *

LATHE MILLING ATTACHMENT

The Haase Machine Works, 411 Fifth Ave., So., Minneapolis, Minn., is manufacturing an attachment for converting a lathe into a milling machine, whenever milling operations can be performed to advantage in connection with turning. This attachment is shown applied to a lathe, in the accompanying illustration. The milling spindle is vertical and is carried by a housing clamped to the toolpost. The drive to the spindle is through a square, universal-jointed shaft connecting through gearing with an overhead countershaft, which, in turn, is driven by a belt from the headstock cone. The feeding move-
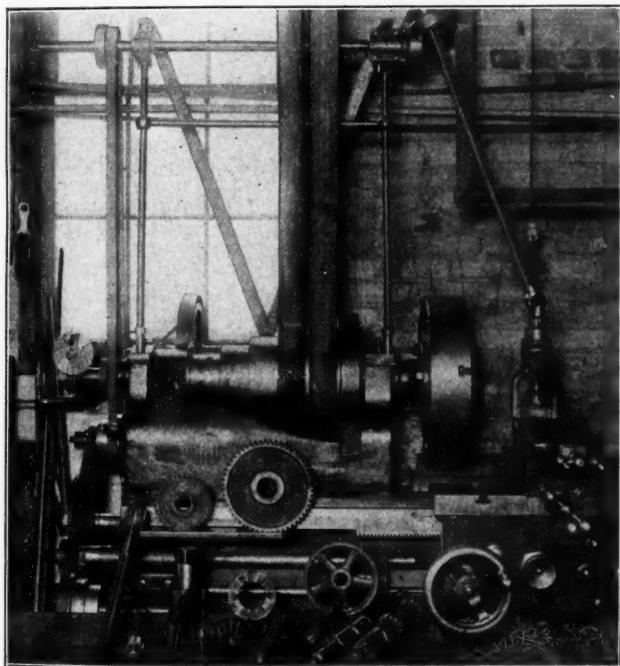
Haase Lathe Milling Attachment

ment for the milling cutter is also obtained from the overhead countershaft, which connects by belt with the regular carriage feeding mechanism, as the illustration shows.

This attachment is intended for cutting teeth in spur and bevel gears, fluting taps and reamers, splining, etc. When the lathe is to be used for milling, the cone pulley is disengaged from the face-gear, so that the spindle remains stationary. The spindle is indexed for gear cutting, fluting, etc., by the index-plate and worm-gearing seen attached to the left-hand end of the spindle. This indexing mechanism is held stationary by the yoke extending from the lathe, and it is expanded in the end of the hollow spindle by a bolt which holds it in position. The overhead driving mechanism for this attachment does not interfere with the regular operation of the lathe, and it can be attached without drilling any holes. The countershaft has, in addition to the two vertical supports, diagonal braces at the rear, which are attached to the back-gear spindle. Some examples of the work done by this milling attachment are shown in front of the lathe in the illustration.

DROP-HAMMER MODEL FOR SALESMEN

When selling or attempting to sell any machine or tool, it is often difficult to make a prospective customer fully appreciate the good points of the design by a verbal description, even though photographs and drawings are used for illustrating the noteworthy features. The Billings & Spencer Co. has adopted a novel plan of using a model in connection with the selling of drop-hammers, for demonstrating the advantages. This miniature drop-hammer, which is illustrated in the accompanying illustration is an exact duplicate of the 3000-pound hammer built by this company. The model only weighs sixteen pounds, whereas the large hammer has a base weighing approximately 5000 pounds and has a height of about twenty feet. This working model is shown to every prospective customer called upon, and it enables the salesman to back up his claims in a very forceful way.

The Billings & Spencer Co. also uses one of these models in the plant at Hartford for

Miniature Drop-hammer used by
Billings & Spencer Salesmen

instructing new workmen in the proper operation of drop-hammers. This makes it unnecessary to use a large hammer for purposes of instruction.

* * *

PORTABLE MOTOR OUTFIT

The portable motor outfit shown herewith is used in a printing press manufacturing plant for testing presses on the assembling floor. The motor is carried on a four-wheeled truck so that it can be moved about easily, and the starter is mounted on top of the motor, which makes a very compact arrangement.
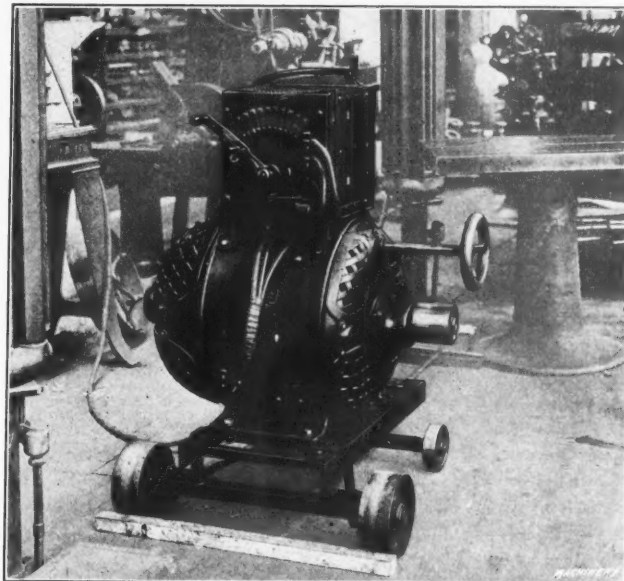
Reliance Adjustable-speed Motor and Starter mounted on Truck for
Testing Printing Presses

A 7½-horsepower Reliance adjustable-speed motor of the armature-shifting type, is used. The motor has a speed range of from 470 to 1880 revolutions per minute, and, in addition, the starter is provided with a special heavy resistance which gives a further speed reduction of 50 per cent for very slow speeds. The main line switch and fuses are mounted on the rear of

the starter. An insulated cable of any desired length may be used for connecting the motor to line plugs at different points about the shop. A similar outfit in another printing press plant is equipped with a flexible shaft and is used for certain boring, drilling and facing operations which can be done to better advantage while the press is being assembled.

* * *

BAR AND CHUCK WORK IN CLEVELAND AUTOMATICS

Automatic and semi-automatic machines are employed at the present time for doing such a large variety of work that a study of the tool equipment used in the production of different machine parts should be of value to the designer and shop man, as well as educational to the builder who is interested in economical manufacturing methods. Fig. 1 of the accompanying illustrations shows three interesting examples of work recently done on some of the machines built by the Cleveland Automatic Machine Co., Cleveland, Ohio.

Sectional and end views of a phosphor-bronze bearing for a gas engine are shown at A, and Figs. 2 and 3 illustrate the
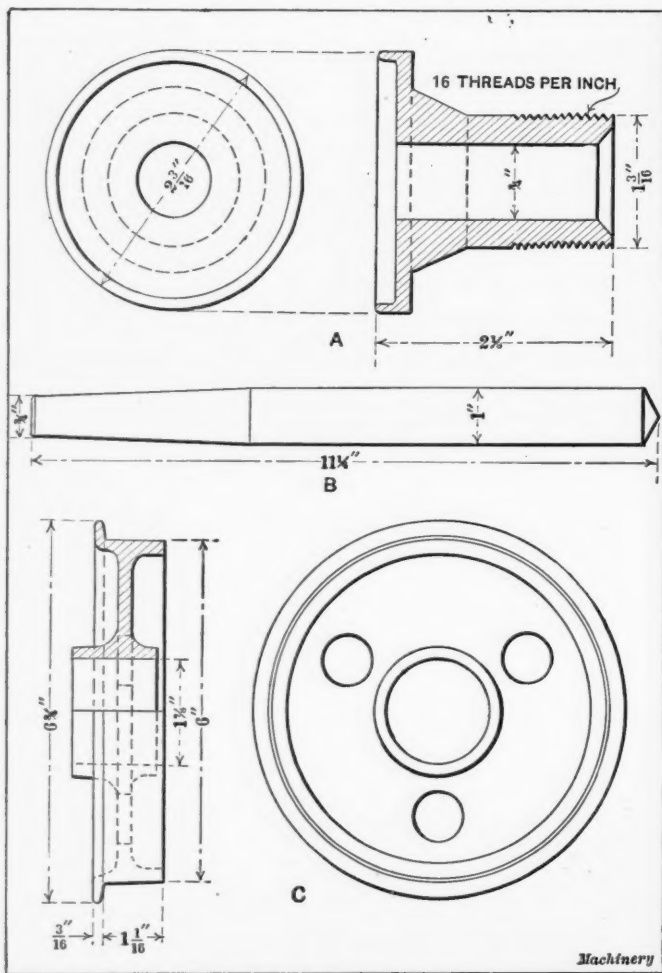

Fig 1. (A) Phosphor-bronze Bearing. (B) High-speed Steel Drill Blank (C) Cast-iron Flanged Wheel

method of turning this part in a standard model turret machine, which is fitted with a tilting magazine attachment. The part is finished in two operations. The rough castings are taken from the magazine and placed in the chuck by means of conveyer B. Fig. 2 shows the position of the turret just after the conveyor has received the casting from the magazine, and Fig. 3 shows the conveyor after it has been indexed in line with the chuck.

The end of the casting is faced and the hole drilled and chamfered by the tools shown at C, which include a three-fluted drill, a chamfering tool for the mouth of the hole and a facing tool for the end. The center turning tool D carries a cutter for roughing the taper part next to the flange (see Fig 1), and there is also a cutter for roughing the straight part and a chamfering tool for the corners. These outside roughing operations are performed at the same time that the tools

at C are in operation, so that six tools are working simultaneously.

Tool E, mounted on the tool-block at the rear of the cross-slide, finishes the taper part next to the flange and also the side of the flange. The boring tool F, which is mounted in an adjustable tool-holder in the turret, next comes into operation, after which the hole is accurately finished by a floating reamer G. While the reaming operation takes place, an overhanging
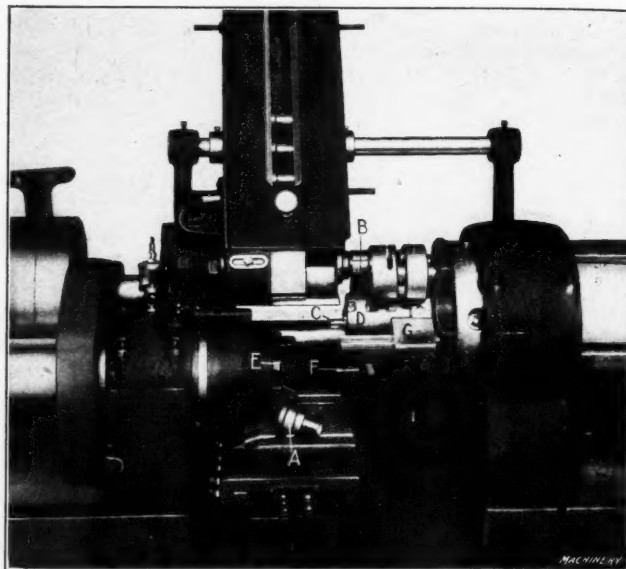

Fig. 2. Cleveland Standard Model Turret Machine equipped with Magazine for Turning Part shown at A, Fig. 1

tool which is mounted in the same holder with the reamer finishes the outside diameter of the flange.

The thread on the end of the casting is cut by a button die. At the time the thread is being cut the peripheral speed of the work is 59 feet per minute, whereas the speed while the other tools are in operation is 90 feet per minute. This completes the first operation, which requires 2 minutes and 30 seconds.

The second operation is that of recessing the flanged end (see Fig. 1). This work is done on the same machine and with the same magazine, but there is a cross-slide tool held in
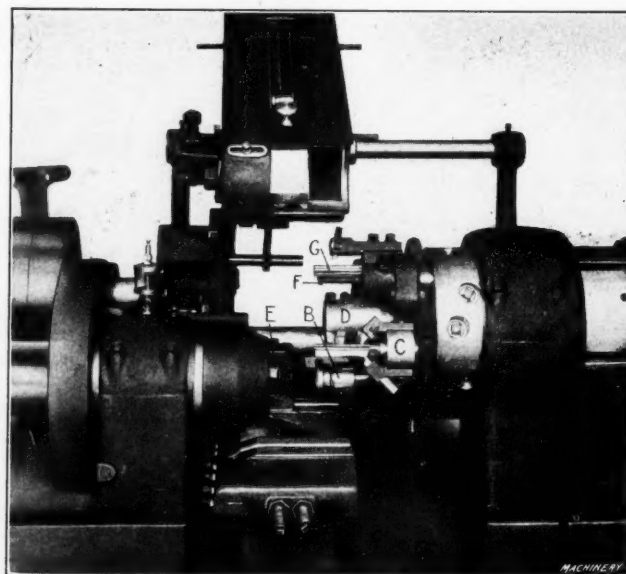

Fig. 3. Conveyor in Position to insert Rough Casting in Chuck

the turret for finishing the flange and counterbore. The second operation requires 50 seconds, so that the casting is finished complete in 3 minutes and 20 seconds. The rough casting weighs 17 ounces, and the finished piece 9 ounces. The principal dimensions are given in Fig. 1.

Another example of work done on the automatic is shown at B, Fig. 1. This is a high-speed steel drill blank which is finished in 6 minutes 35 seconds. It is 1 inch in diameter, 11¼ inches long and has a No. 3 Morse taper shank. The machine used for this work is a regular plain screw machine which is

cammed double, one drum being used to operate the box turn-ing tool, and the other the longitudinal slide and tool for turn-ing the taper shank.

The bar stock is fed through the spindle against a swinging gage stop; then a roller-rest box-tool A (Fig. 4) which is mounted on the tailstock spindle, advances and starts turning the body of the drill blank. On the front cross-slide there is another slide B which moves in a longitudinal direction and is set at an angle for turning the taper shank of the drill blank. This slide is operated by the cams H and I on the large cam drum. These cams control the movement of a slid-ing guide D, which moves independently upon the tailstock spindle and connects with slide B by connecting-bar C. The tool which turns the taper shank of the drill is shown at E. This tool and the box-tool for turning the straight part start and finish their cuts at the same time. The taper shank is considerably shorter than the straight part of the drill blank, so that a slower feed can be used, which is desirable owing to the gradual increase in the depth of the cut. The slide B is adjustable so that it can be set for different tapers.

At the rear of the roller-rest box-tool A there is a holder carrying another set of steadying rolls and a tool F which finishes the point of the drill to the correct angle. A com-bination tool G on the rear of the cross-slide rough-turns the point of the next drill and breaks the corner of the taper shank end of the finished blank as the latter is being cut off. The

Fig. 4. Cleveland Plain Automatic fitted for Turning Drill Blanks

actual labor cost for producing this drill blank is about 7 mills per blank.

An example of chuck work is shown at C, Fig. 1. This is a

Fig. 5. Cleveland Convertible Automatic Turret Machine having Special Equipment for Turning Flanged Wheel C, Fig. 1

cast-iron flanged wheel having a diameter of 6 inches. These wheels are turned in a standard-model, convertible automatic turret machine having a special equipment for this particular

job, as illustrated in Fig. 5. The outside of the wheel is turned to within 0.0015 inch of the given size, and because of the accuracy required, a single-pointed tool is used instead of
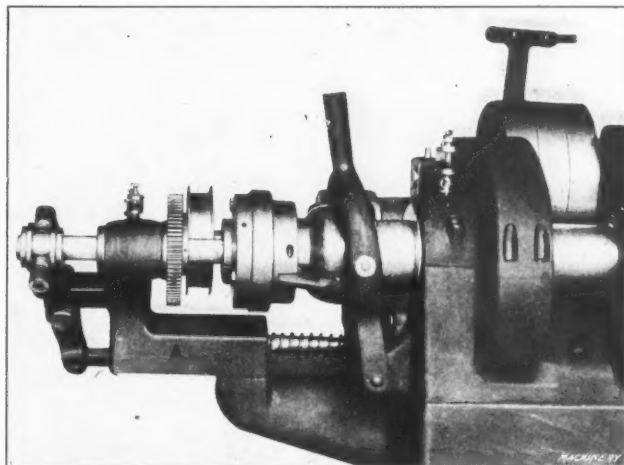

Fig. 6. Driving Mechanism for Boring and Back-facing Attachment

a forming tool, and two cuts are taken. The machine is fitted with a three-jaw universal chuck which has special jaws that engage the three cored holes in the web of the casting. The work is chucked by hand as in any ordinary chucking machine.

There is a boring and back facing attachment having an in-dependent drive mounted at the left-hand end of the spindle head. The rear end of this bar and the driving mechanism are supported by a framework A, as illustrated in Fig. 6. The bar extends through the spindle and, in this particular case, carries a boring tool for roughing and a facing cut-ter which faces the rear end of the hub. At the same time, tool B, which is mounted in the turret, rough-faces the front end of the hub, and a tool on the rear cross-slide rough-turns the outside diam-eter of the wheel and also the top of the flange, so that five tools are working simultaneously at this time. The outside of the w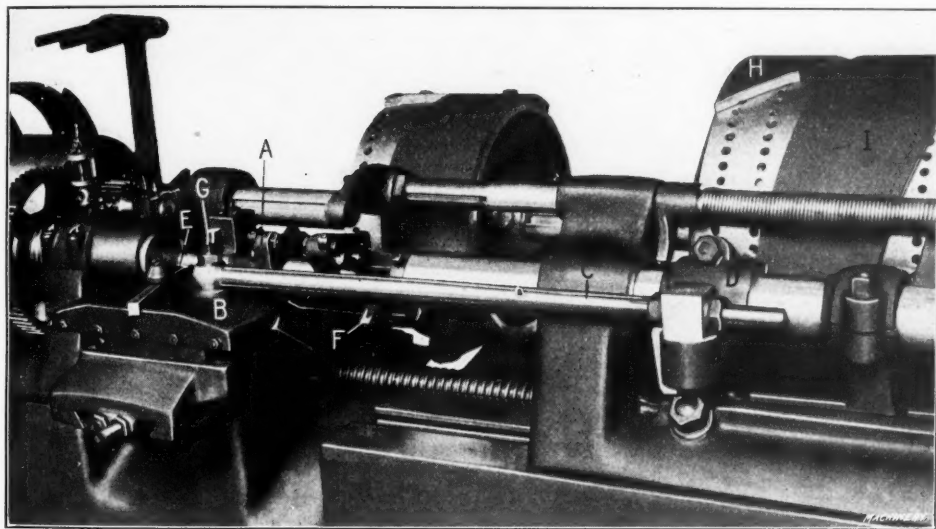heel has a peripheral speed of 50 feet per minute, and the boring cutter is operated at the rate of 80 feet per minute by the independent driving mechanism pre-viously referred to. By changing the driving pulley on the countershaft, the speed of the bar can be varied to suit different classes of work.

The next tools which come into operation are the two held in bar C, which is mounted in the turret. These are finish-boring and facing cutters. While these cuts are being taken, the spindle speed is increased to give a peripheral speed inside the hole of 80 feet per minute. After the finish-boring cut is taken, the speed is reduced to 50 feet per minute on the out-side diameter. The hole is then accurately sized by reamer D, and the tread of the wheel is finished by tool E on the rear cross-slide. The flange of the wheel is finished by one of the two tools mounted on the front cross-slide, while the other faces the rim of the wheel.

The tools on the rear cross-slide move in a longitudinal direction, and the slide upon which the rear tool-block is mounted can be seen at F. The longitudinal movement is obtained by cam drum H which imparts motion to the slide through connecting-bar G. A bell and stop-motion attachment stops the machine after each piece is completed. One of these castings is finished in 3 minutes 45 seconds. This operation shows the adaptability of this machine for chucking operations, as well as for handling bar work of various kinds.

* * *

Always have all bearing surfaces for nuts or heads of cap-screws spot-faced.
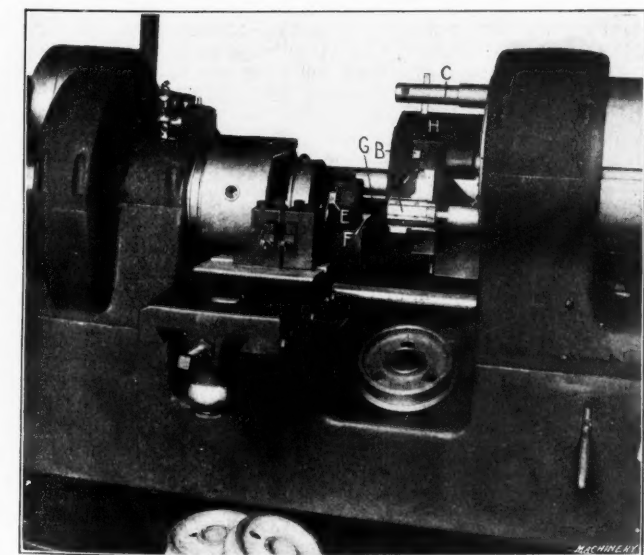
THE ABILITY OF BILL

By A. P. PRESS

Bill came in to see us the other day. Bill was one of our apprentice boys five years ago, and he was noted more for what he didn't do than for what he really accomplished—not but that his ability to turn off work was good enough, but his inherited ability to get clear of doing it was greater still. So putting the two together his abilities seemed to be largely of the last described order.

When Bill came in looking pretty prosperous, and seated himself in the best chair in the office, and took out a fat cigar with a gold band around it, and offered us one of the same brand, we knew that we were right.

"Yes," said Bill, as he got warmed up a little, "I was down to Baltimore one day last week, and as I was strolling around, I wandered into a big machine shop, that had just gone into the assignees' hands. The auctioneer was showing off the machinery in the usual manner, and, of course, I was interested. I did not have any money, but I had on a good suit of clothes, good friends, and a pocket full of these same cigars (which, by the way, are some that my wife gave me at Christmas), pretty good aren't they?

"I was inspecting a big boring mill which was a fine machine, when I noticed a little bunch of buyers over in the corner. When I had sized up the mill, and some of the other large tools pretty well, one of the bunch came over to me."

"Say, Mister, are you interested in this outfit?"

"Sure I am."

"Well, how high do you think you could go?"

"The sky is my limit."

"Now say, stranger, we are making up a little pool on this to buy the whole shop. Do you want to come in?"

"No, I think I had better stick by my lonesome."

"Now see here, that's going to queer the whole thing. What will you take to keep out?"

"Well, I have come quite a ways. I don't like to go home with an empty pocket. What is it worth to you?"

He went back and the bunch got together and back he came.

"Now then if you will keep out of it entirely we will give you an even $500."

"Yes, $500 is all right, but it looks to me as though there was more than $500 in it. Is that cash?"

"No, we will have to give you a check."

"I don't seem to see that. Make it $500 cash and it is a bargain."

Back he went and there was a great taking out of pocketbooks for a few minutes, and then he came back.

"We have got just $450. If you will take it we will make it cash."

"And take it I did," said Bill, "and that is where these good clothes came from, and the vacation too."

Bill has gone, although the flavor of that cigar still lingers in the office, and our opinion of Bill is that he will be noted all his life, not for the things he does, but for the things that others think he is going to do.

And there are others.

* * *

In a paper entitled "The Effect of the Relation of Stroke and Bore in Automobile Engines," presented by Mr. John Wilkinson, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, the author stated that as a pure thermal question there is no apparent reason why the stroke to bore ratio cannot be carried up to and even exceed a ratio of 2. In the mechanical design, however, difficulties begin to appear when the ratio exceeds 1.33, and when the ratio exceeds 1.5 the objections become so strong that there appear to be no compensating features for the increase in weight and expense. An excessively long stroke involves too much weight in the valve mechanism. It might, therefore, be fair, according to the author, in placing general limits on the stroke to bore ratio, to say that it is limited in one direction to 1 by the cooling limit of the piston, and in the other direction to 1.5 by the limits of mechanical adaptability.

COLORING ALUMINUM

A process for coloring aluminum is described in the *Brass World*. This process has been patented by S. Axelrod of Oberschoneweide, Germany. It consists in treating the aluminum surfaces with a solution of cobalt nitrate and then heating the object. The heat changes the color of the surface, and gradations ranging all the way from steel gray to brown and finally black may be obtained, according to the temperature to which the article is heated. The salts should be either neutral or alkaline. The aluminum article is dipped in the salt solution, or the solution may be applied with a brush, the salt having been dissolved in water previous to application. The exact temperature to be used is not stated, but it is rather low, as aluminum melts at a comparatively low heat. It is stated that the colors thus produced will not rub or scale off, and that they are permanent. The inventor also claims that zinc, tin and other metals may be colored by cobalt nitrate or other cobalt salts in the same manner.

* * *

During the first week in August, the centenary of the great Krupp works at Essen, Germany, will be celebrated. The celebration will be attended by the Emperor and many other German rulers, military officers, admirals and civil officials. The festivities will be largely military in nature in order to give emphasis to the important part that the Krupp works have played in military and naval armaments. One feature will be a series of sham battles. Men armed with weapons of the era of the Emperor Maximilian will fight with an army equipped with modern rifles and artillery.

* * *

PERSONALS

John Bath, designer of the Bath grinder and formerly manager of the Bath Grinder Co., Fitchburg, Mass., has been made sales manager of the Reed-Prentice Co., Worcester, Mass.

Robert H. Lasch has resigned his position of chairman and managing director of the Selson Engineering Co., Ltd., London, England, and Mr. Henry M. Sonnenthal has been appointed in his place.

Ira J. Peat has resigned as assistant foreman of the Simplex Time Recorder Co., Gardner, Mass., to take the position of general superintendent of the Long Mailing Machinery Co., of Minneapolis, Minn.

Edward Rivett of the Rivett Lathe Mfg. Co., Boston, Mass., who sailed for Europe in June, will return in October to resume his duties as president of the reorganized company now known as the Rivett Lathe & Grinder Co.

H. A. S. Howarth, a valued contributor to MACHINERY, who for the past year has been assistant professor of mechanical engineering of the Lehigh University, South Bethlehem, Pa., has been appointed assistant professor of machine design at the Carnegie Technical Schools, Pittsburg, Pa.
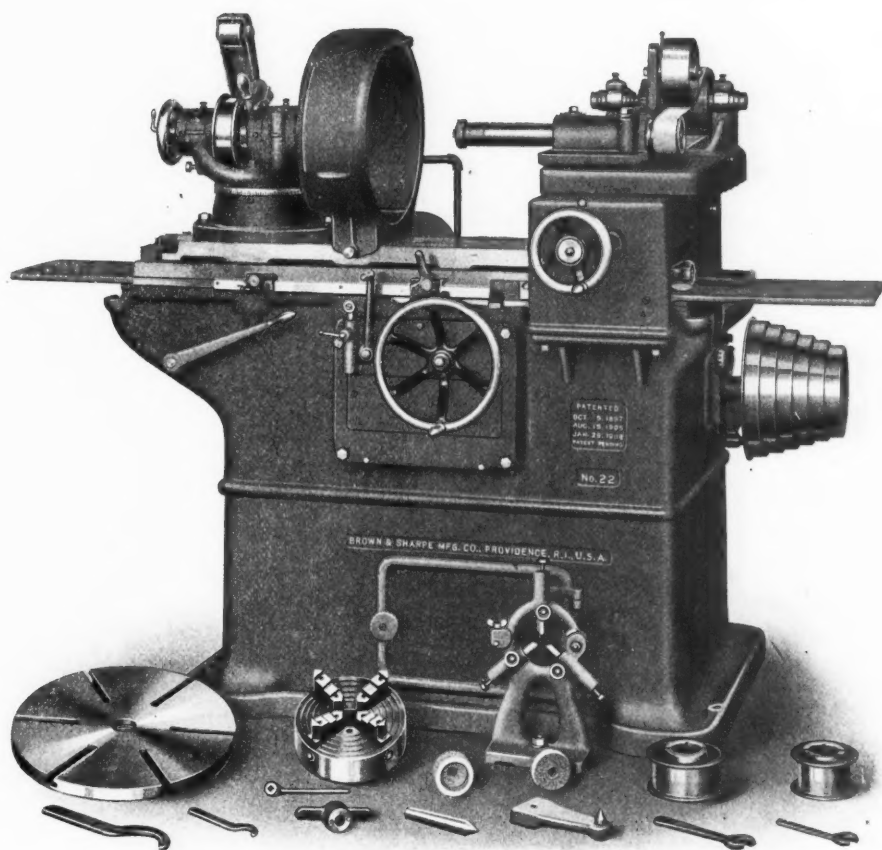
Edwin Rust Douglas, mechanical and electrical engineer, has resigned the position of works manager of the Hero Mfg. Co., Philadelphia, Pa., and is now acting as consulting engineer with that company and with David Lupton's Sons Co., and S. L. Allen & Co., all of Philadelphia. Mr. Douglas will be able to serve others also, to a limited extent, in problems concerning manufacturing and factory organization.

Joseph E. Martin, formerly in charge of the estimating and boring mill department of the Bullard Machine Tool Co., Bridgeport, Conn., has resigned his position to take that of superintendent of the Foster Engineering Co., Newark, N. J. Mr. Martin was with the Bullard Machine Tool Co. for eight years. His friends in Bridgeport and associates in the Society of Mechanical Foremen, of which he was president, gave him a farewell reception.

Gilbert H. Pearsall has been made vice-president of the Jacobs-Shupert U. S. Firebox Co., and will be in charge of the Eastern sales office of that company with headquarters at Room 732, 30 Church St., New York City. Mr. Pearsall will retain his position as secretary of Joseph T. Ryerson & Son with which concern he has been identified since May, 1901. He has been in general charge of the sales of the Ryerson company since January 1, 1905. Prior to that connection he held positions in the traffic and transportation departments of several railway companies.

Charles B. Moore has resigned as vice-president of the American Arch Co., and has been elected vice-president of the Jacobs-Shupert U. S. Firebox Co. Mr. Moore will be in charge of the Western sales department of the company with offices in the Railway Exchange Bldg., Chicago, Ill. Mr. Moore organized the Columbia Boiler Co. in 1900 for the

purpose of manufacturing house heating apparatus and boilers. In 1902 he organized the American Locomotive Equipment Co., and was general manager and a director of that company until 1911, when he was elected its president. He assisted in the organization of the American Arch Co. in 1910 and was elected vice-president and a director of that company in 1911. He also organized the Boss Nut Co., of which he is a director. Mr. Moore is the inventor of a number of locomotive devices, the best known of which are his locomotive brick arches.

* * *

COMING EVENTS

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 9-11.—Ninety-third meeting of the National Association of Cotton Manufacturers at the Griswold, Eastern Point, New London, Conn. C. J. H. Woodbury, secretary, Boston, Mass.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

September 30-October 4.—Autumn meeting of the Iron and Steel Institute at Leeds, England. G. C. Lloyd, secretary, 28 Victoria St., London.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

UPPER IOWA UNIVERSITY, Fayette, Iowa. Catalogue for 1911-1912.

UNIVERSITY OF NEW MEXICO, Albuquerque, N. M. Catalogue 1911-1912, and announcements for 1912-1913.

WORKING MEN'S COLLEGE, Melbourne, Australia. Prospectus for 1912. Frederick A. Campbell, director.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La. Catalogue for 1911-1912, and announcements for 1912-1913.

NEW MEXICO SCHOOL OF MINES, Socorro, N. M. Annual Register for 1911-1912 with announcements for 1912-1913.

DELAWARE COLLEGE, Newark, Del. Catalogue of the officers and students for the year 1911-1912, and announcements for the year 1912-1913.

UNIVERSITY OF UTAH, Salt Lake City, Utah. Catalogue of students for 1911-1912 and announcements for 1912-1913 in the schools of arts and sciences, education, mines and medicine.

IOWA STATE COLLEGE OF AGRICULTURAL AND MECHANIC ARTS, Ames, Iowa. Directory of graduates of the division of engineering, giving the individual records of between 1100 and 1200 graduates.

NEW BOOKS AND PAMPHLETS

THE POLYTECHNIC ENGINEER. Volume XII, 1912. 129 pages, 6 by 9 inches. Published by the undergraduates of the Polytechnic Institute of Brooklyn.

PERSONAL EFFICIENCY. By Charles Frederick Loweth. 16 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 5 of the College of Engineering Series.

ORGANIZATION IN ENGINEERING. By Henry Marison Byllesby. 14 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 4 of the College of Engineering Series.

MOLDING CONCRETE FOUNTAINS AND LAWN ORNAMENTS. By A. A. Houghton. 56 pages, 5 by 7¾ inches. 14 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

MOLDING CONCRETE FLOWER POTS, BOXES, JARDINIERES, ETC. By A. A. Houghton. 52 pages, 5 by 7¾ inches. 7 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR ENDED JUNE 30, 1911. Vol. I. 675 pages, 6 by 9 inches. Published by the Bureau of Education of the United States, Washington, D. C.

A RAPID METHOD FOR THE DETERMINATION OF VANADIUM IN STEELS, ORES, ETC. Published by the Department of Commerce and Labor, Washington, D. C., as No. 8 of the Technologic Papers of the Bureau of Standards.

ON THE MEASUREMENT AND DIVISION OF WATER. By L. G. Carpenter. 48 pages, 6 by 9 inches. Illustrated. Published by the Agricultural Experiment Station of the Colorado Agricultural College, Fort Collins, Col., as Bulletin No. 150.

CONFERENCE COMMITTEE METHODS IN HANDLING RAILWAY LEGISLATION ON MECHANICAL MATTERS. By Charles Arthur Seley. 15 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 2 of the College of Engineering Series.

A NEW ANALYSIS OF THE CYLINDER PERFORMANCE OF RECIPROCATING ENGINES. By Paul Clayton. 104 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 58.

THE STRENGTH OF REINFORCED CONCRETE BEAMS; RESULTS OF TESTS OF 333 BEAMS. By Richard L. Humphrey and Louis H. Losse. Published by the Department of Commerce and Labor, Washington, D. C., as No. 2 of the Technologic Papers of the Bureau of Standards.

THE EFFECT OF ADDED FATTY AND OTHER OILS UPON THE CARBONIZATION OF MINERAL LUBRICATING OILS. By C. E. Waters. Published by the Department of Commerce and Labor of Washington, D. C., as No. 4 of the Technologic Papers of the Bureau of Standards.

TESTS OF THE ABSORPTIVE AND PERMEABLE PROPERTIES OF PORTLAND CEMENT, MORTARS AND CONCRETE, TOGETHER WITH TESTS OF DAMP-PROOFING AND WATER-PROOFING COMPOUNDS AND MATERIALS. By Rudolph J. Wig and P. H. Bates. Published by the Department of Commerce and Labor, Washington, D. C., as No. 3 of the Technologic Papers of the Bureau of Standards.

LECTURES DELIVERED AT THE CENTENARY CELEBRATION OF THE FIRST COMMERCIAL GAS COMPANY, TO SELL GAS AS AN ILLUMINANT.

174 pages, 6 by 9 inches. Illustrated. Published by the American Gas Institute, 29 W. 39th St., New York.

This interesting series of lectures is prefaced with the chronology of the development of gas lighting, beginning 1450 B. C. The importance of gas as an illuminant and fuel, and the growing importance of producer gas in the industrial field, makes this series of lectures of historical and commercial value.

ANALYSIS OF METALLURGICAL AND ENGINEERING MATERIALS. By Henry Wysor. 82 pages, 8½ by 10½ inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $2.

This manual, which is the outcome of an effort to raise the efficiency of the students' work in the laboratory, is a systematic arrangement of laboratory methods, compiled by the assistant professor of analytical chemistry and metallurgy in Lafayette College. Each page of text is accompanied by a blank page for the insertion of notes and data by the user. The condensed, step-by-step directions for making analyses should be appreciated by all chemists and students of chemistry.

THE EFFECTS OF COLD WEATHER UPON TRAIN RESISTANCE AND TONNAGE RATING. By Edward C. Schmidt and F. W. Marquis. 24 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 59.

The bulletin presents the results of tests made to determine the amount of increase in train resistance in cold weather, and the tests show that even in moderately cold weather there is a very definite increase in train resistance over the resistance which prevails at air temperatures above 30 to 40 degrees F. This increased resistance is chiefly due to the lower temperatures of the car journals, and the tests show that the temperature rises very slowly, requiring twelve to fifteen miles travel from the starting point before the resistance has reached its minimum value.

MODERN ILLUMINATION, THEORY AND PRACTICE. By Henry C. Horstman and Victor H. Tousley. 273 pages, 4⅜ by 6¾ inches. Published by Frederick J. Drake & Co., Michigan Ave., Chicago, Ill. Price $2.

This is a handbook of practical information for users of electric light, contractors, electricians, etc. It treats of light, principles of vision, reflection, refraction and diffusion, photometry, calculation of flux from photometric curves, illumination calculations, characteristics of electric illuminants, shades and reflectors, location and height of lamps, color of light, choice of lamps, choice of fixtures, indirect lighting, practical considerations, table of intensities in foot candle for various classes of service, plans and specifications, illumination tables, incandescent light wiring and other tables, glossary of terms and phrases, etc.

ENGINEERING VALUATION OF PUBLIC UTILITIES AND FACTORIES. By Horatio A. Foster. 345 pages, 6 by 9 inches. Published by D. Van Nostrand Co., New York. Price, $3 net.

The demand for information regarding the valuation of public utilities has been growing rapidly during the last few years mainly because, with the increase in supervision of public utilities by commissions which require valuations of properties when permission is asked to change rates or to add to securities for any purpose, engineers have extended their field of activity to include problems of ratemaking. This fact and the public demand that corporations shall receive a fair return on the fair value only of their properties, make it important that those in charge of appraisals shall be familiar with the elements which courts and commissions will consider in passing upon the merits of a valuation. The investigation leading to a decision as to a satisfactory schedule of rates requires the services of a technical expert. Mr. Foster, who has been extensively engaged in appraisals, has produced an excellent work on a subject which is now of broad public importance. After a short discussion of "value," the purposes of its determination, and the directions for obtaining it, an important court opinion by Judge Savage of Maine is given in full, as embodying the best instructions for valuation yet pronounced. An excellent feature of the book is the compilation of forms to be used in making an appraisal, and there are included also extended depreciation tables at various percentages and for various terms of usefulness, which will be found of much service in making valuations. After a short chapter devoted to the cost of appraising a property, the value of "good will" and "going concern value" are defined and discussed, and the opinions of commissions, courts, and individuals are given at some length. Considerable space is devoted to the subject of depreciation, which, like the author's treatment of "intangible value," contains a number of original views. The chapters on amortization, handling of depreciation, and appreciation are interesting. The study of the court decisions as to franchises should go far toward elucidating this complex subject. A clear discussion of capitalization and the control of public utilities follows, and the book closes with copies of some of the decisions of the courts and the syllabuses of a large number of others. In one volume are thus brought together the gist of virtually all important rulings bearing on the subject of valuations, so that not only the engineer but the layman may learn their application in any given case. Mr. Foster's work is distinctly of value.

THE HUMAN FACTOR IN WORKS MANAGEMENT. By James Hartness. 159 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York. Price $1.50 net.

The views on works management of a manufacturer who is a mechanic and inventor, and the president of a well-known and highly successful concern would attract attention, and when those views are on the neglected human factor element, they become extraordinarily interesting. This work by Mr. Hartness sets forth some of the essential principles of industrial economics as represented by his experience and that of many who regard some of the theories of scientific management laid down by its leading exponents with doubt and misgivings. In the discussion of habit the idea is brought out that success depends more on the man than the plan, and that systems are but a means and not the end. Repetition forms habit, and is necessary for success. Contrary to the popular idea, repetition does not degrade, but simplifies and makes work easy. The mere size of an organization does not give it strength; but whether the organization is large or small the advantage lies with that one in which each operation is repeated the most times per individual. Skill is due to continued application. A lathe hand does the most and best work with his own lathe and tools under the conditions with which he has become familiar. But there are all kinds of minds, and not all have the same ambitions and aspirations. There is often lack of sympathy and understanding between those who would lift the masses to what they conceive to be a better plane of thought and living. Inertia of habit and consequent dislike of change of methods is characteristic of workers generally. When the conditions of work are such that methods must be continually changed, inefficiency results. The notorious inefficiency of plumbers on repair work is attributed by the author largely to the strange surroundings of each job and the new conditions that must be met. To make a business pay in the long run, it must be conducted so as to build up those conditions most conducive to the well-being of the workers as a whole; hence the folly of trying to "make a business pay" from the financial side alone. Space will not permit quoting or paraphrasing many more interesting statements bearing on the human factor element in business. The chapters "Some of the Non-Technical Phases of Machine Design" and "Machine Building for Profit," deal with some of the intangibilities of manufacturing. Courage to

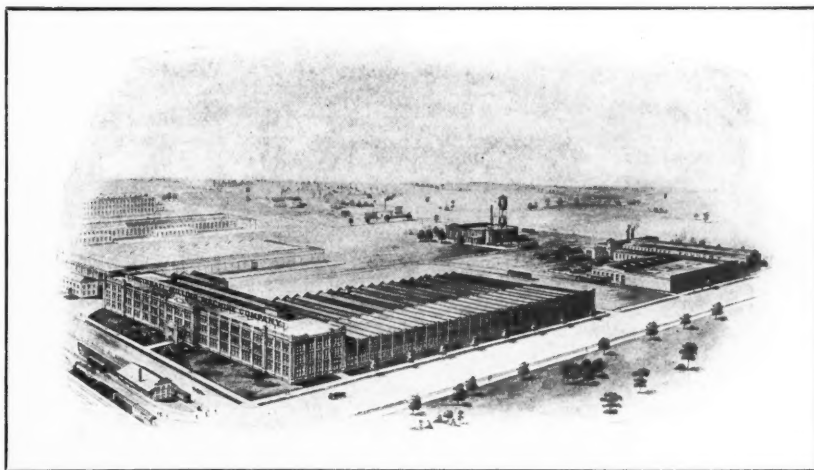discard is as desirable as courage to accept and use. The hero of the drafting-board is the one not afraid to use the eraser, and the hero manufacturer is he who sticks to one thing and makes it successful. The weakness of many concerns and a prolific cause of failure is a constantly changing policy and product. The tendency of individuals to be jacks-of-all-trades is exemplified by manufacturers who will not concentrate on one line long enough to become proficient in its production. "The manufacturer of a great variety of machines in response to a demand by the selling organization is a relic of other days", expresses the perception of the author. His own experience has amply demonstrated the value of developing a specialty and then sticking to it. The book is full of interest and value for manufacturers and students of industrial economics.

NEW CATALOGUES AND CIRCULARS

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y. Catalogue No. 142 on the Green boiler economizers.

INTERNATIONAL GAS' ENGINE CO., Cudahy, Wis. Catalogue No. 12 of "Ingeco" engines operating on gas, gasoline, oil and producer gas.

J. FAESSLER MFG. CO., Moberly, Mo. Bulletin No. 28 illustrating and describing "Faessler" safety sectional boiler tool expander with quick-acting knockout.

SANDERSON TOOL SALES CO., Brown Marx Bldg., Birmingham, Ala. Circular of Sanderson adjustable portable boring-bar for boring straight and taper holes.

C. W. HUNT CO., West New Brighton, N. Y. Catalogue No. 12-1 on industrial narrow gage railways for handling raw and finished materials in foundries, iron mills, power plants, factories, etc.

CHICAGO PNEUMATIC TOOL CO., 1010 Fisher Bldg., Chicago, Ill. Instruction booklet for operating the "Little Giant" car, containing directions for the operation of gasoline engines and motor cars.

WESTINGHOUSE ELECTRIC & MFG. CO., E. Pittsburg, Pa. Circulars 1516, on Baldwin-Westinghouse Electric Locomotives; 1155, on Series Arc Lighting Systems, with Westinghouse Cooper-Hewitt Rectifiers.

WATSON-STILLMAN CO., 192 Fulton St., New York. Catalogue No. 85 on hydro-pneumatic wheel presses, listing and describing over seventy variations in types and sizes of from 60 to 600 tons capacity.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Bulletins 1022 on Automatic Motor Starters for Non-Reversing Direct-Current Motors; 1023, on Type A Knife Switches; and 1024, on Type MC Solenoids.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet entitled "Painting the Smokestack," setting forth the qualities of Dixon's silica-graphite paint that meet the trying service demanded of a smoke-stack paint.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 151 on "Remek" distributing transformers. The bulletin is well printed on pebbled paper which brings out very clearly the characteristics of the half-tone illustrations.

FORT WAYNE ENGINEERING & MFG. CO., Fort Wayne, Ind. Circular of Paul pumping machinery, air compressors, water supply systems, suction pressure systems, deep well pressure systems and pneumatic displacement systems.

BECKER MILLING MACHINE CO., Hyde Park, Mass. Catalogue of carbon and high-speed steel standard cutters, form cutters, hobs for spur and spiral gears, saws, shell end-mills, T-slot cutters, arbors, spring collets, inserted tooth cutters, etc.

FOSDICK MACHINE TOOL CO., Cincinnati, Ohio. Circular illustrating and describing new style 2½-foot and 3-foot National radial drills having back gears and tapping attachment, and adapted for belt, variable speed motor or constant speed motor drives.

F. B. SHUSTER CO., New Haven, Conn. Catalogue of automatic wire straightening and cutting machinery and sheet metal straightening and cutting machinery for straightening and cutting wire and sheet metal to exact lengths from the coil; elastic blow riveting machines; etc.

THOMAS H. DALLETT CO., York and 23rd Sts., Philadelphia, Pa. Bulletin No. 304 describing the Dallett pneumatic wood carving tools. These tools are useful in any branch of the woodworking industry where gouging, roughing and carving work of any description is being done in the usual manner with hand chisels.

AMERICAN VANADIUM CO., 325 Vanadium Bldg., Pittsburg, Pa. Pamphlet on vanadium steels and classification of heat-treatment with directions for application to iron and steel. This valuable treatise should be of great interest to all concerned with the use of steels required to withstand repeated shocks without crystallization.

MONTGOMERY & CO., 105-107 Fulton St., New York. Price list of Grobet Swiss files, illustrated. These are the original Swiss files made by F. L. Grobet, the business of which was originated over 100 years ago. The catalogue shows a large variety of toolmakers' files, and should be in the hands of everyone ordering fine files.

LAMSON CONSOLIDATED STORE SERVICE CO., Boston, Mass. Bulletins of pneumatic tubes, wire cash carriers, cable cash carriers, parcel carriers, message carriers, pickup carriers, sweep-off carriers, selective carriers, tray conveyors, library conveyors, mail conveyors, belt conveyors, special conveyors, small lifts, and light elevators.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins 4953, Large Shell Type Transformers; 4959, The Electrical Operation of Railroad Shops; 4960, Lightning Arresters for Electric Railways; 4962, Electric Power in the Lumber Industry; 4963, Small Direct and Alternating Current Motors Drawn Shell Type; and 4966, Hydro-Electric Power Development.

INDUSTRIAL INSTRUMENT CO., Foxboro, Mass. Bulletin No. 65, of Foxboro improved recording gages, listing nearly 2000 ranges in three sizes covering all purposes and pressures from full vacuum to 10,000 pounds per square inch. Lists are arranged to facilitate quick and easy selection of instruments, and each instrument is assigned a code word for convenience in identification.

UNITED STEEL CO., Canton, Ohio. Booklet on vanadium steel, giving the results of tests on chrome-vanadium steel, demonstrating that this steel has unusually valuable properties. Illustrations show the results of tests on springs, gears, axles, bars, etc. The company is a pioneer in the manufacture of chrome-vanadium steel, and has specialized in its production ever since its introduction.

VANADIUM-ALLOYS STEEL CO., Latrobe, Pa. Booklet on vanadium steel for all purposes, giving characteristics of "Red-cut" high-speed steels; price list of "Red-cut" disks suitable for milling cutters, and information on "Vasco" special steel, etc. The general effect of vanadium on steel is discussed, and, altogether, the booklet will be found of much interest to users of steels.

KELLY REAMER CO., 1547-65 Columbus Road, Cleveland, Ohio. Catalogue of Kelly adjustable reamers, with high-speed steel blades, for boring automobile cylinders, connecting-rods, jigs and all holes requiring accuracy and smoothness of finish. The Kelly reamer has floating cutters which compensate for errors of alignment by "floating" to the center of holes previously bored true.

WATSON-STILLMAN CO., 192 Fulton St., New York. Catalogue No. 86 on the Chambersburg throttle valve, which is claimed to be superior to the ordinary throttle valve in the following particulars: single seat; regrind without removal; no lost motion; internal boiler inspection without removal; provision of inlet for steam at highest point in dome; perfect balance; easy operation; screw or lever control.

FORT WAYNE ELECTRIC WORKS OF GENERAL ELECTRIC CO., 1616 Broadway, Fort Wayne, Ind. Bulletins 1140, on Single-Phase Repulsion Induction Motors, Type SR; 1137, on Belt-Driven Revolving Field Alternators, Form B; 1136, Direct-Connected Type MPL Direct-Current Generators; 1139, on Motor Drives; also instruction book No. 3053 on Multi-Phase Revolving Field AC Generators and Belted Exciters.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Circular on graphite products comprising flake graphite, heavy graphite, machine graphite, waterproof graphite grease, "Graphitoleo," "Everlasting" axle grease, pipe joint compound, traction belt dressing and leather preservative, solid belt dressing, automobile lubricants, silica-graphite paint, stove cement, plumbago crucibles, graphite brushes for motors and generators, etc.

TREADWELL ENGINEERING CO., Easton, Pa. Colored card illustrating the coloring of patterns to indicate finished surfaces, rough surfaces and core prints. The standard colors adopted are those recommended at a joint meeting of the Steel Founders' Society and the American Society for Testing Materials, for use on patterns in steel foundries, and are: red for finished surfaces, yellow for rough surfaces, and black for core prints.

CURTIS & CURTIS CO., 8 Garden St., Bridgeport, Conn. Catalogue of Forbes patent pipe cutting and threading machinery for hand, belt, or electric power. The catalogue is a very complete production, giving full data on all of the many sizes and styles of portable machines built. The largest machine cuts off and threads pipe from 2½ to 12 inches diameter, and its approximate net weight is 3650 pounds, while the smallest is adapted for ¼-inch to 2-inch pipe, and weighs 155 pounds.

GOULD & EBERHARDT, Newark, N. J. Catalogue of high-duty shapers and attachments, illustrating details of construction and giving full data of 14-inch, 16-inch, 20-inch, 24-inch and 34-inch sizes. These shapers are regularly furnished with four-step cone pulleys and are also provided with electric motor drive for either direct or alternating current. A large variety of shaper attachments is illustrated, including tilting base for shaper vises, circular or cone mandrel, automatic vertical feed, traverse head, index centers, circular table, concave attachment, convex attachment, auxiliary front cross feed, etc.

NATIONAL TUBE CO., Frick Bldg., Pittsburg, Pa. Booklet entitled "The Modern Boiler Tube," containing the story of its evolution and development and some expert opinions on its efficiency. The booklet is a valuable contribution to the literature on boiler tubes, briefly tracing their development since the patent of Henry Osborn of Birmingham was granted in 1812 for the manufacture of gun barrels by bending wrought-iron plates over a circular and tapered mandrel and welding the heated metal under a tilt hammer. Illustrations show the tests applied by the National Tube Co. to boiler tubes, and the data of tests supplied by the American Society for Testing Materials are included.

TRADE NOTES

REED-PRENTICE CO., Worcester, Mass., requests manufacturers' catalogues for the Prentice Bros. department, 667 Cambridge St.

BLAKESLEE FORGING CO., Plantsville, Conn., is about to erect a three-story machine shop, 30 by 160 feet, and a forge shop 220 by 50 feet; also an annealing room 32 by 76 feet.

TATE-JONES & CO., INC., Empire Bldg., Pittsburg, Pa., report that orders were recently received for large oil burning furnaces from the Falls Hollow Staybolt Co., of Cuyahoga Falls, Ohio, and the Pennsylvania Steel Co., of Steelton, Pa.

TAYLOR IRON & STEEL CO., High Bridge, N. J., has opened an office in Pittsburg at 301 Oliver Bldg., in charge of Mr. James S. Morrison. The office was opened to meet the increased demand for manganese steel castings in Pittsburg and vicinity.

RHINELAND MACHINE WORKS CO., 140 W. 42nd St., New York, will open a place of business in Cologne or Frankfort, Germany, in the near future for the purpose of selling American machinery and tools and other manufactured products. The company is interested particularly in articles which will be used by manufacturers in general, and especially patented devices.

W. M. PATTISON SUPPLY CO., 197-211 St. Clair Ave., Cleveland, Ohio, has purchased the real estate, buildings, factory and power equipment of the Long Arm System Co., of Cleveland, manufacturers of automobile engines, transmissions, axles, gears, etc. The factory equipment consists of 205 machine tools, 10 furnaces, 21 motors and a large assortment of smaller tools which will probably be offered in lots to suit purchasers.

H. W. JOHNS-MANVILLE CO., Madison Ave. and 41st St., New York, has applied the J-N "Line-O-Lite" electric light lamps with much success to showcases in hardware stores, especially those containing machinists' tools, cutters and other tools requiring bright illumination to bring out their characteristics. The "Line-O-Lite" lamp is made in tubular form, twelve inches long, which shape makes it a good light distributor, yet easily concealed.

TATE-JONES & CO., INC., Pittsburg, Pa., report that the Massillon Bridge & Structural Co., Massillon, Ohio, has placed an order with them for a complete oil burning furnace equipment for a new plant. The placing of this order is the result of long-continued and satisfactory use of Tate-Jones & Co's. furnaces by some of the officers of the Massillon Co., while connected with another bridge plant for which Tate-Jones & Co., Inc., installed furnaces several years ago.

HESS-BRIGHT MFG. CO., Philadelphia, Pa., has transferred its offices to its new factory at 17 E. Erie Ave. The old quarters at 21st and Fairmount Aves. have for the past two years been inadequate for the rapidly growing business of the company, and the new site, which covers about thirteen acres, affords ample room for a much-needed expansion. The factory buildings are one-story high and embody the most advanced ideas on modern factory arrangement and construction.

ALLEN MFG. CO., INC., 135 Sheldon St., Hartford, Conn., has moved into the old Henry & Wright Mfg. Co's. plant in order to be able to care for its rapidly growing business of manufacturing the Allen safety set-screw. The company has established a Canadian branch at 29 St. David's Lane, Montreal, Canada, which will manufacture safety set-screws for the Canadian trade. Safety set-screws are now made for lathe dogs, and special safety screws will be made to order from ¼ inch to 1 inch diameter.

WARNER & SWASEY CO., Cleveland, Ohio, has filed an application for an increase of capital stock from $500,000 to $1,000,000. The increase of capital is to be provided for making an extension of the company's business. During the past three years the company has doubled the capacity of the plant, and is now contemplating the construction of an additional building on the east side of its present structure. The new building will be used largely for shipping and storage purposes. The officers of the company are Ambrose Swasey, president; Worcester R. Warner, vice-president; and Frank A. Scott, secretary and treasurer.

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